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## PATENT SPECIFICATION

953,303

DRAWINGS ATTACHED.

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## COMPLETE SPECIFICATION.

## Sheet Handling Apparatus.

- We, WEST VIRGINIA PULP AND PAPER COMPANY, a Corporation organised under the laws of the State of Delaware, United States of America, of 230 Park Avenue, New York 17, New York, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—
- This invention relates to sheet handling apparatus capable of delivering sheets at a reduced speed from said apparatus to receiving means such as a stacker. The apparatus is further capable of performing the operations of cutting, sorting, and stacking material in a single continuous operation at high speed on a single web of material.
- In conventional sheeting operations at a paper mill, webs from a plurality of rolls are combined and directed through a sheet cutting machine at relatively low speed, in order of 150 to 300 feet per minute. The sheets are cut approximately one inch over-size in each dimension to allow for a guillotine trimming operation which follows. Between the cutting and trimming operations, the sheets are manually handled for ocular inspection, sorting and counting. Substantially more paper than required to fill the customer's order must be cut to assure an adequate allowance for loss due to inspection and sorting. Since the amount of paper that will be rejected in the sorting operation is never known in advance, frequent over-runs or under-runs of cut paper occur. The over-runs of course end up as storage problems or "broke"; the under-runs as delays in deliveries and in scheduling problems. The trim losses often amount to 10% or more of the original good paper. A great amount of floor space is required for the inspection and sorting, and intermediate storage. Much manual labor is required, largely of a heavy, tedious and/or repetitive nature.
- The finished stacks of paper contain repeating sequences of individual sheets from a number of different rolls of paper, and this gives sheet to sheet differences in color, finish, ink receptivity and other characteristics that affect printability of the paper. The printing press operator can adjust his press to print any one of the sheets well, but not all of them well with one pressing setting.
- While single web cutting on conventional equipment is entirely possible, the low rate to which the advance of the cut sheets for stacking must be limited makes the operation generally uneconomical. Stacking velocities of 250 feet per minute are about the maximum that most papers will stand without having the leading edges damaged by the impact of the sheets against paper stops.
- The edge slitting and cutting of multiple webs in the conventional cutter produce a quantity of paper dust due to cutting through the combined thickness of the multiple webs. The dust gets between the sheets and is almost impossible to remove. This dust creates a very serious problem in printing plants, filling up and often damaging the printing plates, and causing printing results of inferior quality.
- In multiple web cutting, on even the best available quipment, due to the thickness of the cut and to slippage between webs, the cut sheets will vary in size and squareness beyond the allowable tolerances. This makes necessary the guillotine trimming operation, with its extra equipment, labor and trim losses.
- It is quite obvious that multiple web cutting virtually precludes automatic inspection

[Prior Art]

and sorting of the cut sheets as a continuous part of the sheeting operation.

The present invention overcomes all the above mentioned difficulties of conventional sheeting operations by novel means which will now be described.

To aid in understanding the invention, and as part of this Specification, the following drawings of certain practical and advantageous illustrative embodiments are included, in which:—

Figure 1 is a comprehensive, purely diagrammatic view of the preferred embodiment of the invention;

Figure 2 is a fragmentary diagrammatic view in sectional, side elevation, showing in some detail the sheet transport system from the sheet cutter to the second sorter-stacker unit;

Figure 3 is a fragmentary view in sectional side elevation of a typical sorter-stacker unit;

Figure 4 is a fragmentary view, partly broken away, of a collecting drum and associated mechanism;

Figure 5 is a fragmentary view, partly broken away, of a transfer drum;

Figure 6 is a fragmentary view in sectional side elevation, showing in detail a combination of sheet guide, sorting flipper and collecting drum;

Figure 7 is a fragmentary plan view, partly broken away, of the mechanism of Figure 6;

Figure 8 is a diagrammatic view of driving means for the sheet transporting tape system;

Figure 9 is a diagrammatic view of the general drive arrangement for the entire machine;

Figure 10 is a diagrammatic view of a D.C. motor drive arrangement for the transfer drum;

Figure 11 is a sectional view of a sorter-stacker unit showing in schematic form the operating mechanism for the sorting and transfer flippers, and showing the sheet counting head;

Figure 12 is a plan view of the timing mechanism of Figure 4;

Figure 13 is a vertical sectional view of the timing mechanism of Figure 4;

Figure 14 is a block diagram of the general control system for the machine.

#### GENERAL DESCRIPTION AND OPERATION.

In the preferred embodiment of the invention as shown in Figure 1, a roll of paper is placed in the unwinder 2 with the web therefrom moving at high speed through a constant tension device 4, through slitters 6 where it may be edge trimmed and/or slit as required, past web cleaner 8, through draw rolls 10, around tension roll 12, over inspection roll 14 where it is viewed by in-

spection device 16, through feed rolls 18 and to rotary sheet cutter unit 20 where it is cut into sheets. Each sheet then travels up inclined sheet conveyor 40 to the No. 1 sorter-stacker unit 100.

As illustrated, No. 1 sorter-stacker unit 100 is stacking sheets classified as "seconds". No. 2 sorter-stacker unit 200 is stacking "firsts". No. 3 sorter-stacker unit 300 is in stand-by condition, ready to accept delivery of "firsts" or "seconds" as may be required due to completion of a stack in either of the other two sorter-stacker units. Any of the three sorter-stacker units can be programmed to receive "firsts" or "seconds", or be put in stand-by condition.

If the sheet approaching No. 1 sorter-stacker unit 100 is a "first" as determined by the inspection device 16, it will by-pass the No. 1 sorter-stacker unit 100 and be picked off the sheet conveyor at the No. 2 sorter-stacker unit 200 where it will be slowed down and delivered onto the "firsts" stack of sheets. If the sheet had been a "second", it would have been picked off the sheet conveyor at the No. 1 sorter-stacker unit 100. If the sheet had been classified as a "reject", it would have by-passed all the sorter-stacker units and would have been delivered into the broke chute 30.

Paper speeds up to 1000 feet per minute or more at the unwinder may be attained. However, final speed of sheets as they are delivered onto any of the stacks is always appreciably less than 250 feet per minute. Means for slowing the sheets at delivery to the stacks, together with means for high speed sheet sorting, form the major part of this invention and will be described in full detail later herein.

Conventional equipment up to and including the sheet cutter unit 20 may be readily obtained from manufacturers of paper making and converting equipment. While a turret type unwinder with flying paster is illustrated and preferred due to its ability to furnish a new roll without stopping operation, other simpler types of conventional unwinders may be used.

The length of sheet cut depends on the length of web fed during a cutting cycle of a conventional flying cutter 20. A common drive is provided for the cutter drum and for the web feeding means. The cutter drum is positively driven from the common driver in fixed relation thereto, while a manually settable change speed transmission unit is interposed between the common driver and web feeding means, for causing any chosen one of a wide variety of selected lengths to be consistently and precisely fed out and cut. The change speed unit 415 is desirably a positive change gear unit. The change gear unit employed in the present illustrative machine is adapted to provide

sheets from about 24 to 49 inches in length at uniform intervals of one-sixteenth inch. Other adjustable ratio mechanism may be employed.

5 The illustrative inspection device 16, capable of giving multiple quality classifications, is known as such. For the purpose of the present disclosure it is sufficient that an inspection mechanism is provided which  
10 scans the web, develops a predetermined signal voltage if the sheet length is of "seconds" quality, and a greater predetermined signal voltage if the sheet length is of "rejects" quality, producing a "seconds" signal in the  
15 first instance, and both "seconds" and "rejects" signals in the second instance.

The number of sorter-stacker units used depends on the production requirements of the installation. Three sorter-stacker units  
20 make up the preferred system. This permits stacking two different classifications of sheets and having an extra sorter-stacker unit in stand-by condition so that a unit containing a finished stack can be withdrawn  
25 from service and a fresh unit substituted, without loss of operating time on the machine. Together with the flying splice unwinder, this permits 100% running time except for paper breaks or other malfunctions,  
30 maintenance and resetting pursuant to changes of output requirements.

Where automatic inspection and sorting is not required but high speed single web sheeting is desired, a simplified single stacker  
35 unit, similar to the sorter-stacker unit 100, but without the sorting feature, may be used. Description of this will be given later. Such a unit could also be readily adapted to stack sheets from high speed,  
40 web fed printing presses.

#### SHEET CONVEYOR.

Sheets leaving the sheet cutter unit 20 are picked up and transported by the inclined  
45 sheet conveyor 40 to the first sorter-stacker unit 100. This conveyor is inclined rather than level, so that the equipment up to and including the cutter may be mounted at floor level. For most installations the arrangement as shown in Figures 1 and 2 will be  
50 found preferable.

A larger scale view of the inclined sheet conveyor and associated equipment is shown in Figure 2. Web 30 coming to the cutter  
55 drum 21 is shown cut into sheets 31, 33 and 34 which are shown disposed at various locations between top tapes 42 and bottom tapes 43 and 101. The top tapes 42 consist of a set of  $\frac{1}{4}$  inch wide by .050 inch thick plastic belts spaced on 2  $\frac{3}{4}$  inch centers and  
60 sufficient in number to extend slightly beyond the edges of the widest sheets which the machine is capable of handling. Dimensions given throughout this Specification are strictly for purposes of illustration and are

not to be interpreted as limitations. It will  
65 be seen that this set of tapes is carried on rolls 44, 45, 46, 47, 48, 49, 50 and others not shown in this view. Roll 47 is the drive roll for this set of tapes.

Bottom tapes 43 are similar in structure  
70 and spacing to the top tapes and lie directly beneath the top tapes. The bottom tapes are carried on rolls 49, 51, 52, 53, 54 and pulleys 140. Roll 54 is the driver for this set of tapes and is driven in a manner similar  
75 to rolls 47, 172, and 272 (see Figure 3) as will be described later.

Roll 50 is so disposed that it causes tapes to contact tapes 43 and exert a slight pressure upon them. This forms a nip between  
80 the tapes causing a gripping action on a sheet just before it is cut loose from the web by cutter drum 21. Roll 50 is adjustable in the directions of the arrows passing through it. It is normally positioned to  
85 cause gripping of the sheet slightly before the sheet is severed from the web. The tapes always run faster than the paper web, as will be explained later, and hence the sheets are quickly accelerated to tape speed as soon as  
90 they are cut. This also accounts for the spacing between sheets 31, 33 and 34 as shown.

Top tapes 42 extend for the full length of the machine as shown in Figure 1. Bottom  
95 tapes 43 only extend to the first collecting drum 104. Additional bottom tapes 101, 201 and 301 are provided between the collecting drums 104, 204 and 304, and the "rejects" chute 80 as shown in Figure 1.  
100 All these tapes 42, 43, 101, 201 and 301 run at the surface speed of the collecting drums 104, 204 and 304.

A small roll 41 (Figure 2), driven at tape speed, is located as close to cutter drum 21  
105 as possible, to direct the sheets onto the sheet conveyor and to keep the paper travelling past the cutting point in a straight line.

#### SORTER-STACKER OPERATION.

110 The three sorter-stacker units shown in Figure 1 are all substantially identical. As illustrated in Figures 1, 2 and 3, the No. 2 sorter-stacker unit is stacking sheets classified as "firsts". Sheet 34, a "firsts", is  
115 shown in Figure 3 as being transported by tapes 42 and 101 over guides 202 to sorting flipper 203 which is in the raised or accepting position. Sorting flipper 203 then directs the sheet down and around collecting  
120 drum 204 where it is held in place on the drum by tapes 205 and transfer guides 234. This No. 2 sorter-stacker unit is typical of all the sorter-stacker units and is shown in detail in Figure 3. Sheet 34 is shown as  
125 having been fully accepted in Figure 2.

Transfer flipper 206 is shown in its up position in Figure 3, in the act of stripping

a packet of five sheets 35 from the collecting drum 204 and directing it onto the transfer drum 207 where the packet is held in place by tapes 208. It will be noted that the trailing edge of the five sheet packet is in line with the arrow "x" shown on the collecting drum 204. This point x on the collecting drum 204 is the main indexing point used in timing all the operations of the sorter-stacker unit. It marks the point where the trailing edge of any length sheet will always fall. After originally synchronizing this point on the collecting drum 204 with the trailing edge of any normally delivered sheet, no further adjustment of the drum or its drive shaft will be required except upon reassembly of the machine after repairs, or maintenance on the machine drives.

As the collecting drum 204 rotates, the trailing edge of the five sheet packet leaves the collecting drum 204, and the transfer flipper 206 is moved back to collecting position, as shown in Figure 11, before the leading edge of sheet 34 reaches it. Thus sheet 34 is directed around the collecting drum 204 toward guides 202, and is held to the drum by tapes 209. Sheet 34 will then completely circle the collecting drum 204 and will continue to do so until removed by the transfer flippers 206. Assuming that sheet 33 which follows sheet 34 is a "first", it will be directed onto the collecting drum 204 and will be deposited directly on top of sheet 34 with edges in exact register. Some explanation as to why this will occur is in order. The cutter drum 21 and the collecting drums 104, 204 and 304 are positively connected together by means of the machine drive in one-to-one ratios, as will be shown in more detail later under the heading, "General Machine Drives". Thus when the cutter drum 21 makes one revolution, all the collecting drums 104, 204 and 304 will likewise make one revolution. As stated previously, the sheet transport tapes travel at the same speed as the surface speed of the collecting drums. Thus, these tapes will travel a distance equal to the circumference of a collecting drum for every revolution of the collecting drums and therefore, every revolution of the cutter drum 21. For the purpose of illustration, the circumference of each of the collecting drums 104, 204 and 304 is taken as 56 inches, and the sheet being cut is assumed to be 40 inches long. Illustratively, the axes of successive collecting drum shafts 128, 228, 328 are spaced apart by uniform intervals each equal to a drum circumference. This is a desirable but not an essential relationship.

The tapes 42, 43, 101, 201 and 301 travel 56 inches for every cut, causing the trailing edges of the sheets to be situated on the tapes at 56 inch intervals and with 16 inches

between sheets. Therefore, since a trailing edge occurs every 56 inches, and 56 inches is the circumference of the collecting drums 104, 204 and 304, the trailing edges of sheets collected on a collecting drum will fall directly on top of each other. This will not be exactly true because the circumference of the collecting drum increases slightly with each sheet collected. However, for practical purposes the deviation due to this cause is so small as to be of no consequence. From the above data, it will be evident that the distance from the cutting point at the sheet cutter unit 20 to the point x on any collecting drum is necessarily an integral multiple of the circumference of the collecting drums.

The collecting drum 204 can be set to collect only "firsts". If a "seconds" or a "rejects" sheet comes along, the sorting flipper 203 will move downwardly into the closed position indicated by the dotted lines in Figure 3, permitting the sheet to travel over and past sorting flipper 203 toward the next sorter-stacker unit.

When a fifth sheet comes onto the collecting drum 204, and just before it reaches the transfer flipper 206, such transfer flipper will be caused to move upward into stripping position as shown in Figure 3, and all five sheets will be stripped as a packet from collecting drum 204 and directed onto the transfer drum 207. During this transfer, both collecting drum 204 and transfer drum 207 will be rotating at exactly the same surface speed. As soon as the five sheet packet is clear of the collecting drum 204, the transfer drum 207 starts slowing down and attains a minimum speed equal to about 15% of its original speed just as the leading edge of the five sheet packet 35 contacts back joggers 210. The transfer drum 207 is then accelerated to the speed of the collecting drum 204, ready to accept another five sheet packet as soon as it has been collected.

En route from the transfer drum 207 to the stack 213, the sheets, transported by tapes 208, are stripped from transfer drum 207 by means of strippers 214, and pass under rubber rolls 215 and over an air pipe 218. As the sheets settle down on the stack, the joggers 210, 211 and 212, assisted by air jet conduit 219, move the sheets into exact registry with the sheets already on the stack.

Five has been chosen as the number of sheets to complete a packet on a collecting drum for several reasons. In the first place, the collection of five sheets affords ample time for the slow-down-speed-up cycle of the associated transfer drum. Secondly, the five sheets, compressed by the tapes into a firm packet, have sufficient body and stiffness to cause them to be carried across the stack without crumpling. For very light papers, the collection of 10 or more sheets

may be found to be preferable. Modifications of the control system can be contrived to collect any reasonable, desired number of sheets.

- 5 The angular relation between the collecting drum and the transfer drum ( $w$  in Figure 11) is arbitrarily selected, 36 degrees appears to be a satisfactory value. Less than 36 degrees makes the unit greater in length and height; more than 36 degrees tends to make the wrap of tapes 209 (Figure 3) around the collecting drum rather short.

- 10 An air pipe 220, (Figure 3), has  $\frac{1}{4}$  inch holes positioned between each pair of successive guides 202, and directed toward the top of the collecting drum. The air from this pipe causes the sheets to smoothly follow the contour of the bottom of the sorting flippers 203 until engaged by tapes 205. Otherwise, the sheets tend to flutter and wrinkle at this point.

#### COLLECTING DRUM.

- A partial cross section and assembly of a collecting drum 204 is given in Figure 4. 25 The collecting drum must have a circumference greater than the length of the longest sheet to be handled, preferably at least 10 to 15% greater. This is necessary in order to provide a gap between the two ends of the sheet, or packet of sheets, so that the tips of the transfer flipper 206 (Figure 3) can get in and out of the collecting drum grooves 221 without contacting or damaging the sheets. This gap is also necessary between sheets on the transporting tapes to permit operation of the sorting flippers 203. In the mechanism as illustrated herein, the gap is necessarily at least one-eighth of the drum circumference or  $45^\circ$ . This 30 allows for a maximum sheet length of 49 inches, and the minimum gap amounts to one-seventh of the maximum sheet length.

- The collecting drum may be constructed as a casting, as a weldment, or formed of reinforced plastic, or fabricated by other means. A series of grooves 221 approximately 1 inch wide by one-half inch deep are formed in the face of the drum. The lands 222 between the grooves are one and three-quarter inches wide. The grooves permit the tips of the transfer flippers 206 to enter and strip the sheets from the drum.

- A series of  $\frac{3}{16}$  inch holes 223 arranged as shown are provided for holding the leading edge of the first sheet collected to the collecting drum by vacuum. Vacuum is supplied to the inside of the drum through stationary vacuum plate 224, faced with wear plate 225 and connected to a source of vacuum by duct 226. Holes 227 in the end web of the drum give access for the vacuum to the inside of the drum. Holes 223 do not extend the full circumference of the drum, but are limited to such area that they

can hold the leading margin at least, of any length sheet for which the machine is designed. The vacuum required inside the drum is in the order of  $\frac{3}{16}$  inch as measured by a water column manometer. This measurement is with all holes open; that is, not covered by paper or tapes. When covered by paper the vacuum rises to  $\frac{1}{4}$  inch of water.

The use of vacuum at the collecting drum is preferred in order to insure a tight hold on the leading edge of the first sheet collected on the collecting drum. Without vacuum, the leading edge of this sheet, when passing the transfer guides and flippers may lift off slightly causing the sheet to creep slightly backwards on the drum every revolution. In case a single sheet has to be held on the drum for a number of revolutions, as can happen due to sorting, the sheet if allowed to slip would get completely out of register and could cause a jam-up at the transfer flippers when a transfer is made. All sheets after and including the first sheet tend to adhere to one another as a result of having the air squeezed out from between them by the tapes around the collecting drum. The air trapped in the grooves in the collecting drum tends to prevent adequate adherence of the first sheet to the collecting drum. Mechanical gripper fingers for this purpose could be used, but I find the vacuum to be simpler.

Collecting drum 204 (Figure 4) is mounted on shaft 228 by means of keys and set screws (not shown). Synchronizing adjustment of the drum can only be effected by adjustment of the drum shaft relative to the shaft drive. The shaft is supported by means of bearings 229 on frames 230. On the left outboard end of shaft 228 is rigidly mounted a miter gear 291 which engages a miter gear 292 on a shaft 701 of a timing assembly 700, which will be described later under the heading, "Control System". Inboard at the same end are mounted by key and set screws (not shown) sprocket 294 and 295 which drive the tape driving rolls, which drives will also be shown in detail later under the heading, "Tape Systems and Drives". Inboard at the right end of the shaft is mounted by key and set screws (not shown) timing cam 293. The action of this cam will be described later. Outboard at this end on shaft 288 are mounted by keys and set screws (not shown) sprockets 297 and 299, and timing belt pulley 296. Sprockets 297 and 299 are the main drives to the collecting drum. Pulley 296 drives, by means of timing belt 501, a slow-down-speed-up mechanism 500, Figure 9, which drives the transfer drum. Such slow-down-speed-up mechanisms 500 used have included drives employing elliptical gearing, non-linear gearing, and gear mechanisms of

epicycloidal type, and in general such mechanisms are indicated in Figure 9. However, the preferred driving means for the transfer drum is a D.C. motor drive as shown in Figure 10, and is the drive which will be explained in detail later for purposes of this Patent Specification.

#### TRANSFER DRUMS.

Design and assembly of a transfer drum 207 is shown in Figure 5. This drum is normally identical in size and grooving to the collecting drum just described. The transfer drum does not require vacuum since the sheets contact it for less than one revolution and cumulative slippage cannot thus occur. The drum mounts on shaft 231 with keys and set screws (not shown). The shaft is supported in bearings 232. Outboard on the right end of the shaft is mounted with key and set screws (not shown) timing belt pulley 233 which is driven by timing belt 502 from the slow-down-speed-up drive mechanism 500 or from the D.C. drive unit to be described later. While the diameter of the transfer drum is preferably the same as that of the collecting drum, it may be larger or smaller as long as the surface speed ratios are not changed.

While the transfer mechanism described herein is illustrated as a drum, it may take the form of a tape transporting system having the same slow-down-speed-up characteristics as the transfer drum. The tape system may be driven by any one of slow-down-speed-up mechanisms mentioned above.

#### PAPER GUIDES AND FLIPPERS.

Figures 6 and 7 give enlarged details of paper guides 202 and sorting flippers 203. Transfer guides 234 and transfer flippers 206 are generally similar. Figure 6 is a partial sectional elevation, while Figure 7, is a top view at the back side of the machine.

Referring to Figure 6, the guides 202 can be made of nylon or other material and be about  $\frac{3}{4}$  inch thick. Each is attached to a stationary shaft 235 by means of clamping screw 236 and pointed set screw 237. A hole is drilled in the shaft for the set screw 237 to maintain exact alignment of an individual guide 202 with the other guides on the shaft. The guides 202 are centered on the grooves in the collecting drum as shown in top view, Figure 7. In this view will also be seen tape pulleys 240 and 241 arranged on shaft 235. Spacer rings 242 are used to fill the gaps next to the guides. Set collars 238 clamp the various elements together on shaft 235. It will be noted that pulleys 241 are slightly smaller in diameter than pulleys 240. This is done so that the paper being carried forward by tapes

101 will not be urged back by the reverse running tapes 209. Structural details of the larger pulley 240 are shown in the sectional view of one of these larger pulleys on shaft 245. Ball bearing 240a has pressed onto its outer race a ring 240b, which is crowned as shown in order to keep the tapes in place. Pulleys 241 are identical, except the diameters are slightly smaller. The ball bearing shown is the wide inner ring sealed type, factor lubricated. Shaft 235 is supported at each end by bearings 239, mounted on the machine frame 230. Near the back frame, a clamp arm 243 is attached to the shaft. The outer end of the clamp arm is rigidly fastened to the frame by screw 244. Transfer guides 234 shown in Figure 3 are constructed and mounted in a similar manner to guides 202.

Sorting flippers 203 are constructed, and mounted on shaft 245, similar to guides 202. Shaft 245 is supported by bearings 246 mounted on front and back frames 230. Shaft 245 has rigidly attached to it arm 247 by which it is rotated to move the sorting flippers 203 up and down. The sorting flippers 203 are shown in the down position in Figure 6. The extreme end of arm 247 operates between adjustable rubber faced travel-limit screws 248 and 249. Links 250 and pins 251 and 252 connect the arm to a pneumatic cylinder assembly 153, which supplies the power for moving the sorting flipper 203. Links 254, located as shown, together with pins 255 and 256 also connect arm 347 to cam arm 257. Cam arm 257 pivots about pivot shaft 258 carried in bearings 259 and 260 (see Figure 7). At the end of cam arm 257 is mounted cam follower 261 which engages cam 293. Cam 293 has inner track 262 and outer track 263. Gap 264 is the only place where the cam follower can be shifted from one track to the other. This gap is located midway between the leading and trailing ends of the longest sheets for which the collecting drum 204 is designed. This makes it impossible for the sorting flippers 203 to operate except in the space between the two ends of the sheet, even though the pneumatic cylinder may be activated slightly ahead of time.

Transfer flippers 206 are operated by a mechanism similar to the above, comprising arms 265, 266, links 267, 268, pivot shaft 169 and pneumatic cylinder 270 as shown in Figure 11. The cam follower 271 operates in tracks 262 and 263 of cam 293.

The strippers 214 (Figures 3 and 11), mounted below the transfer drum 207 and extending into the grooves of the transfer drum 207, serve to remove the packets of sheets from the transfer drum 207.

#### TAPE SYSTEMS AND DRIVES.

Figure 3 shows the complete tape system

for the No. 2 sorter-stacker unit and is typical of all three sorter-stacker units.

Tapes 101 and 42 are shown delivering sheet 34 to collecting drum 204. Sorting flippers 203 are shown in their raised position, directing the sheet 34 onto the collecting drum 204. Tapes 101 pass around ball bearing pulleys 240 mounted on shaft 235. Guides 202 and smaller ball bearing pulleys 241 are also mounted on shaft 235, as shown in Figures 6 and 7.

Tapes 209 leaving the ball bearing pulleys 241 pass around driving rolls 278 and 280 mounted on shafts 279 and 281, respectively, and onto pulleys 241 mounted on shaft 286, and around a portion of collecting drum 204 back to the starting point. Tapes 205 are similarly mounted at the opposite side of the collecting drum 204, passing around driving rolls 274 and 276 mounted on shafts 275 and 277 respectively.

Tapes 208 leave the ball bearing pulleys 240b on shaft 286, pass around transfer drum 207, onto ball bearing pulleys 283 mounted on shaft 284, over two rollers 282 and thence back to pulleys 240b. These tapes are driven only by contact with the transfer drum 207. Rubber rollers 215, mounted on arms 216, which arms are freely pivoted on shaft 217, keep the packet of sheets in contact with the tapes 208 until delivered onto the stack 213.

Tapes 201, which, assisted by tapes 42, transport sheets from the No. 2 sorter-stacker unit 200 to the No. 3 sorter-stacker unit 300, are driven by driving roll 272 mounted on shaft 273. Rollers 282 snub the tapes around the driving roll 272. Additional rollers 282 on top of tapes 42 depress the tapes slightly to insure firm gripping of the sheets by the tapes.

Figure 8 shows the driving arrangement for the tape drive rolls. Sprockets 294 and 295, mounted on shaft 228 of No. 2 collecting drum 204, are the main drive sprockets for the arrangement shown. Sprocket 295 drives the lower tape drive roll 272 (Figure 3) by means of chain 451 over sprocket 450 which is fast on shaft 273. Sprocket 453, also fast on shaft 273 of drive roll 272, drives rolls 274, 276, 278 and 280 (Figure 3) by means of chain 454 over sprockets 455, 456, 457 and 458 fast on shafts 275, 277, 279 and 281, respectively, of rolls 274, 276, 278 and 280. Sprocket 294 likewise drives upper tape drive roll 47 (Figure 1) through chain 460 over sprocket 461 fast on shaft 285 of drive roll 47. Sprocket 452, 459 and 462 are take-ups for chains 451, 454 and 460, respectively.

Other positive driving means may be used. The following data may be considered typical for a small size machine.

Collecting drum	18.000 inches diameter	65
Large driving rolls 273	8.473 inches diameter	
Small driving rolls 280	3.359 inches diameter	70
Tape thickness 101, 42	0.050 inches diameter	
Sprockets 294, 295	36 teeth	
Sprockets 450, 161	17 teeth	
Sprockets 453	40 teeth	75
Sprockets 455, 456, 457, 458	16 teeth	

#### GENERAL MACHINE DRIVES.

The general drive arrangement of the entire machine is given in Figure 9. This drawing is diagrammatic rather than strictly to scale, for purposes of showing the arrangement rather than details.

Motor 400 is preferably a variable speed D.C. type, in order to provide smooth start-up and acceleration and to provide dynamic braking for emergency stops. It drives jack shaft 404 by means of pulley 401, timing belt 402 and pulley 403. The ratio of this drive determines the maximum machine speed. Vee-belts or other types of driving mechanisms could be used here.

Jack shaft 404 has mounted on it sprocket 405 which, through roller chain 406 and sprocket 407, drives jack shaft 408. The ratio between jack shaft 404 and jack shaft 408 is 2:1; jack shaft 408 runs at half the speed of jack shaft 404. Jack shaft 408 has mounted on it spur gear 409 which engages spur gear 410 on No. 1 collecting shaft 128 in a 1:1 ratio. These spur gears 409 and 410 are necessary to reverse the direction of rotation as required by the drums.

Mounted on shaft 128 is sprocket 197 which together with roller chain 298 and sprocket 297 drives shaft 228 of No. 2 collecting drum in a 1:1 ratio. In like manner sprocket 299, chain 398 and sprocket 399 drive shaft 328 of No. 3 collecting drum.

Also mounted on shaft 128 is timing pulley 196 which, with timing belt 501 and pulley 502, drives the input shaft 505 of slow-down-speed-up drive unit 500. Timing pulley 504 on the output shaft of the slow-down-speed-up drive unit 500, together with timing belt 503 and pulley 133, in turn drives shaft 131 of the No. 1 transfer drum 207. Similar drives may be used at the No. 2 and No. 3 sorter-stacker units.

Returning to jack shaft 404, pulley 411 mounted thereon which, together with timing belt 412 and pulley 413, drives input shaft 414 of the drive unit 415. The drive unit 415 permits rapid original and repetitive, precisely predetermined, sheet length settings over a wide range. Other conventional change gear mechanisms may be used in this place.

Also mounted on input shaft 414 is sprocket 416. By way of silent chain 417, sprocket 416 drives sprocket 418 in a 2:1 ratio. Sprocket 418 is mounted on shaft 21a of the cutter drum 21. Thus, it will be seen that the cutter drum 21 and the collecting drums 104, 204 and 304 all rotate at the same speed. Initial synchronizing of the collecting drums is done by slipping the various chain drives involved until point x on each drum coincides with the training edges of sheets reaching the drum.

The output shaft 319 of drive unit 415 has mounted upon it a sprocket 420 which, together with silent chain 421 and sprocket 422, drives shaft 18a of the web feed rolls 18. The ratio of this drive depends on the output-input ratio of the drive unit 415, and the circumferences of the driven feed rolls 18 and draw rolls 10 of Figure 1. A 1:1 ratio timing belt drive comprising sprockets 423, timing belt 424 and sprocket 425 connects shaft 10a of the web draw roll 10 to shaft 18a, thus turning the draw rolls 10 at the same speed as the feed rolls.

When a flying splice unwinder is used, additional drives from output shaft 419 of the drive 415 must be provided to drive the unwinder input shaft 2a. These are provided as shown by sprockets, roller chains and jack shafts numbered 426 to 436 inclusive.

Obviously, many variations on the driving means may be used such as lineshafts with bevel gear units, etc., as long as the required ratios and directions of rotation are maintained, the flexure is kept to a minimum.

#### D.C. MOTOR TRANSFER DRUM DRIVE.

As previously mentioned, several types of slow-down-speed-up mechanisms have been used to provide the delivery cycle operation of the transfer drum, such mechanism being indicated generally as unit 500 on Figure 9. The preferred driving means, however, for the transfer drum is a variable speed D.C. motor 950 as shown in Figure 10. This motor has directly coupled to it, a D.C. tachometer generator 951 whose voltage output is directly proportional to speed. The motor 950 drives the transfer drum 207 at a 4.6:1 ratio by means of timing belt pulley 952, timing belt 953 and timing belt pulley 954. Thus, for example, the transfer drum 207 will run at 250 r.p.m. when motor 950 is running at 1150 r.p.m.

The collecting drum 204 is driven from the main machine drive by means of sprocket 297 and chain 298 (Figure 9). Attached to the collecting drum shaft 228 is pulley 958. Belt 959 connects pulley 958 to pulley 960 on a second tachometer generator 961, with a 4.6 to 1 step-up drive. This tachometer generator 961 is identical in

output characteristics to tachometer generator 951. Thus, when both tachometer generators 951 and 961 are driven at the same speed, their outputs will be identical. It will be noted that tachometer generator 961 will be running at 1150 r.p.m. when the collecting drum 204 is running 250 r.p.m. Thus, when the collecting drum 204 and the transfer drum 207 are running at the same speed, the outputs of the tachometer generators 951 and 961 will be identical.

The outputs of the two tachometer generators 951 and 961 go to the D.C. motor control unit 962, where they are bucked against each other in a Wheatstone bridge circuit. Connected in the bridge circuit is a sensitive unbalance detector. In case any unbalance is detected, indicating that the two drums are not running at the same speed, the detector causes the D.C. motor controller to modify the current to motor 950 in such manner as to bring the transfer drum 207 back into speed synchronization with collecting drum 204. Since both tachometer generators 951 and 961 will then be running at the same speed, their outputs will be identical and the bridge circuit will be restored to balance. By this action it is possible to drive the collecting drum 204 at any desired machine speed, and transfer drum 207 will assume the same speed. Equipment for this service, and for the further purpose about to be described, is capable of maintaining the speed synchronization within 0.1%, which is quite adequate for this service.

Such equipment comprises a motor with a tachometer generator attached thereto; a motor control unit mounted in a cabinet, said tachometer generator being foot mounted.

For the slow-down-speed-up cycle of transfer drum 207, a relay in the D.C. motor control unit 962, responsive to a timing signal from the sorter-stacker unit control system shifts connections to the bridge circuit, so that the output of tachometer generator 951 is bucked against a manually adjustable fixed voltage instead of against the output of tachometer generator 961. This fixed voltage is manually adjusted to be the same as tachometer generator 961 when the collecting drum is running at some selected slower speed, for example 50 r.p.m. The transfer drum 207 will then quickly come to this slower speed and remain at this speed until a second timing signal from the sorter-stacker unit control system restores the relay to its original position. The transfer drum 207 then returns quickly to the same speed as the collecting drum 204 and continues to run at this speed until another slow-down signal is sent to the D.C. motor control unit 962. Appropriate devices in the D.C. motor control unit 962 limit the



deceleration and acceleration to suitable values for the slow-down-speed-up cycle, and also prevent hunting or spurious speed oscillations. This system of driving the transfer drum 207 permits stacking sheets of paper at a constant delivery velocity regardless of the operating speed of the machine.

A modification in the D.C. motor control unit 962 permits having the sheet delivery velocity proportional to machine speed instead of being constant as just described. In this case, for the slow-down cycle, instead of bucking the voltage output of tachometer generator 951 against a fixed voltage, it is bucked against a selected portion of a voltage divider connected across the output of tachometer generator 961. Since the output voltage of tachometer generator 961 is proportional to machine speed, the voltage from the voltage divider, while lower, will still be proportional to machine speed. Thus, the speed of the transfer drum 207 will be lower but will be proportional to machine speed. Speeds and ratios illustrated are typical but in no way are they limitations.

#### STACKER DETAILS.

All three sorter-stacker units 100, 200 and 300 shown in Figure 1 are substantially identical. No. 2 sorter-stacker unit 200 will be described in detail as shown in Figures 1, 3, and 11. It consists of hydraulic stack elevator 288, platform 289, stacking skid 290, joggers 210, 211, 212, air pipe 218, air jet conduit 219, and stack tamper 600.

The stack elevator 288 shown is a conventional oil-hydraulic type. The elevator platform 289 is approximately the size of the maximum size sheet which can be handled by the machine. In its lowest position the top of the platform is substantially at floor level to permit removal of the finished skid of paper by lift truck or other means. The paper may be stacked directly on a shipping skid 290 as shown.

The joggers 210, 211 and 212 are of the high speed impact type and serve to move sheets into exact registry with sheets already on the stack. Other jogger mechanisms may be used.

Air pipe 218 and air jet conduit 219 (Figure 3) are quite essential for satisfactory stacking. Air pipe 218 has  $\frac{1}{8}$  inch holes 218a spaced on 4 inch centers and is supplied with low pressure (3 p.s.i.) air at both ends. The air is directed horizontally under the incoming packet of sheets and partially floats the packet onto the stack. The air jet conduit 219 contains four vertical exit slits 219a which are  $\frac{1}{8}$  inch wide by  $1\frac{1}{2}$  inches high, and which direct low pressure (3 p.s.i.) air into the end of the stack near the top. This action separates

the individual sheets slightly, permitting the joggers 210, 211 and 212 to move all incoming sheets into register with those already on the stack.

For some grades of paper it is necessary to use the stack tamper 600 to remove the excess air from between the sheets. This is particularly true for large sheets of light weight papers. The stack tamper 600 is lowered until the tamper feet 610 contact the stack, as shown by dotted positions 610a. The stack tamper 600 is quickly raised automatically to the condition shown in Figure 3, an instant before the next packet of sheets emerges from the rubber rollers 215. The tamper feet 610 may be moved to the extreme up position 610b for example to facilitate the removal of sheets from the top of the stack.

Also shown in Figure 11 is a conventional ream flag inserter 670 which portions out a length of paper ribbon 672 onto the top of stack 213 when a signal is received from a ream counter (not shown). Items 673 are flags which have already been inserted. Also shown is a photoelectric stack height controller 679 comprising lamp unit 680 and photocell unit 681, which automatically controls the height of the stack elevator 288. The photocell unit 681 receives light reflected from the sheets and if the level of the stack rises above the center of the light spot projected from lamp 680 the photocell actuates a relay which lowers the stack.

#### CONTROL SYSTEM.

Figure 14 gives a simplified block diagram of the controls for a three sorter-stacker unit machine. The main control panel 741 contains the controls for starting, stopping, and adjusting the speed of the entire machine. The motor control unit 742 contains the direct current supply for the main drive motor 400 and the various circuit breakers, speed regulators and auxiliary devices for operation of the motor.

Each sorter-stacker unit has an operator's control panel 740. These are located on the frame of each sorter-stacker unit 100, 200 and 300 as shown in Figure 1. The control panels 740 are used to set each unit to collect "firsts", "seconds", or remain idle in stand-by condition.

A sheet cut line shift synchronizer comprising a disc 750, with a light slit 751, is mounted on one end of the cutter drum shaft 21a. A light source 752 is mounted at one side of the disc 750. Photocell 753 mounted opposite the light source 752 and on the other side of the disc 750 sends a signal to a pulse former, not shown, every time the light slit 751 in the disc 750 passes by the photocell 753. The pulse former shapes this signal into a pulse which it sends along

by way of cable 755 to the shift registers SR1, SR2, and SR3.

The inspection head 16 continuously observes by photoelectric means the entire web of paper passing around a chrome plated backing roll beneath it. Two distinct types of defects may be observed and independently evaluated by the equipment. These are defects which cause a change in specular reflection such as creases, wrinkles and glossy spots, and defects which causes a change in diffuse reflection such as dark spots, holes, and smudges. Six calibrated dials (not shown) on the inspection control panel 17 are used to set up the "firsts", "seconds" and "rejects" levels.

The inspection control panel 17 receives information from the inspection head 16, classifies the information according to the seriousness of the defects observed in the web of paper and sends out "seconds" and "rejects" signals to the shift registers SR1, SR2, and SR3 associated respectively with the sorter-stacker units 100, 200, and 300. The inspection mechanism is connected to put out "seconds" signals through an electrical conductor 756 which is connectable to the shift registers SR1, SR2, and SR3, respectively, through parallel switches 1S1, 1S2, and 1S3. The inspection mechanism is connected to put out "rejects" signals through an electrical conductor 757 which is connectable through parallel, normally open switches 1R1, 1R2, and 1R3 to a common return conductor 757a, in each instance by way of relay winding 757b.

If a sorter-stacker unit is set to stack "firsts", any "seconds" signals will be fed to the shift register signal delay unit associated with that sorter-stacker unit where such signals are held until the sheet which caused the "seconds" signal has arrived at the point where the sorting flipper of that particular sorter-stacker unit is lowered to cause the sheet to by-pass that sorter-stacker unit.

If a sorter-stacker unit is set to stack "seconds", any "seconds" signals will be fed to the shift register signal delay unit associated with that sorter-stacker unit where such signals are held until the sheet which caused the signals is at a point where the sorting flipper of that particular sorter-stacker unit is raised to direct such sheet onto the collecting drum. A "rejects" signal received from the inspection equipment neutralizes the effects of all "seconds" signals from that particular sheet by energizing relay winding 757b, thereby opening an associated switch 756a and suppressing the transmission of the "seconds" signal, thus keeping all sorting flippers down and permitting such sheet to pass on to the broke chute.

With the sorter-stacker unit 100 collecting "seconds", the sorter-stacker unit 200

collecting "firsts" and the sorter-stacker unit 300 held in reserve, the switches 1S1, 1S2, 1S3, 1R1, 1R2, and 1R3 will be maintained as illustrated in Figure 14. Since the switches 1R3 and 1S3 are both open, no defect signal will have any effect on sorter-stacker unit 300, and the normally closed sorting flipper 303 of unit 300 will remain down at all times. The sorting flipper 203 of unit 200 will remain in the open or receiving position to accept sheets unless a "seconds" signal is put out from the inspection mechanism. When a "seconds" signal is received by shift register SR2, it will at the proper time shift the sorting flipper 203 to the closed position where it will remain for a full revolution of collecting drum 204, and the sheet will be collected at the sorter-stacker unit 100. The sorting flipper 103 of unit 100, which is set to stack "seconds", will remain in its normally closed or down position, and the sorting flipper 303 of unit 300, which is in stand-by condition, is always closed. A "seconds" signal causes the flipper 103 of unit 100 to be temporarily shifted at the proper time to the open or receiving position. A "rejects" signal, always accompanied by a "seconds" signal, closes both sorting flippers 103 and 203 and the sheet goes to the reject chute.

The shift register signal delay unit (SR1, SR2, SR3) is a conventional device which stores defect signals from the web of paper before it is cut into sheets and releases these signals to activate the sorting flippers at the correct time to properly sort the particular sheet producing the defect signal, or signals in case the sheet contains more than one defect. Electronic shift registers are available from a number of manufacturers. They consist of a number of signal storage elements. One storage element is required for each sheet in transit from the inspection point to the sorting point. Each instant a future cut line of the web passes the inspection point, the shift synchronizer 750—755 shifts the signal contents of each storage element to the next storage element and so on, the defect signals from a sheet arriving at the appropriate sorting flipper just prior to the time that the sheet arrives there.

A conventional photoelectric sheet sensor 691, Figure 11, located at each sorter-stacker unit, counts sheets approaching the sorter-stacker unit. This count is registered by way of cables 692 in a conventional 5-sheet counter (not shown) unless a "no count" signal is received from the shift register signal delay output, such signal indicating that the sheet will by-pass the collecting drum, and therefore must not be counted. The 5-sheet counter then puts out a signal every time five sheets have been counted at the particular sorter-stacker unit, and initiates

the transfer of the five sheets from the collecting drum to the transfer drum by activating the transfer flipper.

5 Precise timing of the operation of the sorting flipper, the transfer flippers, the transfer slow-down-speed-up drive and the stack tamper of each sorter-stacker unit is extremely important. When operating at 10 200 sheets per minute, the sorting and transfer flippers must make their full travel in less than 35 milliseconds. Rotary timing switch unit 700, location and details for which are shown in Figures 4, 12, 13 is used for this purpose. The rotary timing switch 15 unit 700 is driven from the collecting drum shaft 228 by means of miter gears 291 and 292. Gear 292 is mounted on shaft 701 which is supported in bearings 701a and 701b. Shaft 701 therefore rotates turn for 20 turn with the collecting drum 204. The upper portion of the shaft has attached thereto arm 702 which carries permanent magnet 703 at its end. At the extreme 25 upper end of shaft 701 is mounted pointer 709. Both the pointer 709 and magnet 703 are so aligned on the shaft that they are at pointer S in Figure 12, when pointer x on collecting drum 204 is at pointer S in Figure 11. The pointer S of the rotary timing 30 switch 700 is at zero degrees on the etched scale of transparent cover 710 of timing unit housing 707. Mounted around the inside of housing 707 as shown are hermetically sealed magnetically operable switches 704 35 having mercury wetted contacts. Switches of this type can be operated very precisely for billions of times. The switches 704 are held in clips 705 and attached to the housing 707 by means of screws 706. It can be seen 40 that as the collecting drum rotates the magnet 703 will be caused to rotate past the various switches, thus timing the various operations labeled in Figure 12. These switches are used to energize relays which 45 in turn supply the properly timed actuating signals to the various operating mechanisms, namely the sorting flipper 203, the slow-down drive 500, the transfer flipper 206, and the stack tamper 600. It will be noted that 50 the "reject start" switch is initiated well in advance of the actual time that the flipper 203 will operate. This allows time for the solenoid valve 713 to operate and so pre-load air cylinder 253, so that the instant the 55 gap in cam 293 reaches cam roller 261, the cam roller 261 can fly through, thus permitting sorting flipper 203 to drop down and allow the approaching sheet to pass by. This same advance timing applies to the "reject 60 stop", "transfer start" and "transfer stop" switches. "Slow-down start" and "slow-down stop" switches are only very slightly advanced, since these actions have very little time lag.

65 There is nothing particularly novel in the

various control circuits that would not be apparent to one versed in the art of electrical and electronic control. Therefore, actual circuit diagrams have not been included in this Specification. Their inclusion together 70 with the necessary explanations would more than double the volume of the Specification, and add little, if anything.

#### SIMPLE SINGLE STACKER MACHINE.

A single stacker machine involving no 75 inspection and no sorting, and employing a single slow-down and stacker unit or two such units for alternative service, would be very useful for many applications. There are considerable advantages in precise single 80 web cutting and stacking at high speed, even if the sheets have to be manually inspected later. For example, all sheets would come from a single web of paper, and the separate operation and waste involved in 85 trimming would be eliminated.

With the need for sorting, and hence the irregular arrival of acceptable sheets, obviated, the transfer and slow-down of the sheets can be programmed through a simple 90 non-linear gear train giving the slow-down-speed-up cycle as described previously. This gear train would make one complete revolution for every 5 revolutions of the collecting drum and would thus put the transfer drum 95 through its complete cycle including running at the same surface speed of the collecting drum during the transfer period, then slowing down as the sheets are delivered to the 100 stacker, then speeding back up to collecting drum speed in preparation for the next transfer. Such a sheeter could be used to considerable advantage in the plant of a paper user who finds it necessary or desirable to purchase paper in roll form, and to 105 cut it into sheets of varied lengths in accordance with his production requirements.

The modified machine is desirably like the machine in Figure 1 from the beginning 110 through the flying cutter and up to the first sorter-stacker unit, except that there is no inspection mechanism. There is just one sheet collecting, transferring and stacking unit which accepts all sheets. All mechanisms for sorting sheets, for assigning different duties to different units and for controlling the transfer means through a counting of accepted sheets, are omitted.

The collecting drum has no shiftable sorting flipper but has a flipper fixed in the 120 sheet accepting position, for directing all the sheets onto the collecting drum. Tapes, sheet guides, transfer flipper, delivery and stacking equipment are identical to those described in previous sections. 125

#### SUMMARY.

From the foregoing Specification, it can be seen that the invention makes possible a

radical departure from the conventional method of sheeting and processing of the sheeted paper prior to shipping. It makes possible a better, more uniform product, a reduction in space and manpower required, and an overall saving in cost.

#### WHAT WE CLAIM IS:—

1. Sheet handling apparatus capable of delivering sheets at a reduced speed from said apparatus to receiving means such as a stacker, wherein a constant, high speed sheet conveying means is provided for conveying sheets to a collecting drum which is constructed and arranged to receive individual sheets one after another from said conveying means and to accumulate them in registered packets of predetermined number, said collecting drum being rotated by driving means at a constant peripheral speed substantially equal to the speed of the sheet conveying means, delivery means automatically effective when the prescribed number of sheets has been accepted for accumulation on the collecting drum to bring about delivery of the resulting sheet packet to a transfer conveying means, said transfer conveying means being driven by variable speed drive means at the peripheral speed of the collecting drum throughout said delivery and being automatically effective when the delivery of a packet of sheets to the transfer conveying means has been completed to so modify the variable speed drive means that the transfer conveying means is put through a slow-down and restoration cycle, said transfer conveying means being first slowed down smoothly until the packet of sheets has been discharged to a receiving mechanism, and then restored to the collecting drum speed by a time no later than that at which the next accumulated packet of sheets on the collecting drum becomes ready for delivery to the transfer conveying means.
2. Apparatus according to Claim 1, wherein the slow-down and restoration cycle of the transfer conveying means is extended through more than one revolution of the collecting drum but through something less than the total number of full revolutions of the collecting drum required for the accumulation of a packet of sheets of the prescribed number on the collecting drum, at the maximum possible rate of one sheet per revolution of the collecting drum.
3. Apparatus according to Claim 1 or 2, wherein said variable speed drive means comprises a variable speed direct-current drive motor, and a pair of direct-current tachometer generators, said first tachometer having a common drive means with the collecting drum causing them to be operated in a fixed speed relationship to one another, said second tachometer being connected to said transfer conveying means for operation

by said direct current drive motor in the same fixed relationship, said direct-current motor being controlled by power supply control mechanism which includes readjusting means normally opposing the outputs of the tachometers to one another and being automatically responsive to any unbalance of said output to readjust the speed of the direct-current motor in a direction to restore balance and bring about and maintain correspondence of transfer conveying means speed to collecting drum speed, and reference voltage means are provided capable of producing a set reference direct-current voltage of much smaller magnitude than the output voltage of the first tachometer, said readjusting means including time switching means which, throughout a predetermined operating period, substitutes the set reference voltage for the output voltage of the first tachometer in the power supply control mechanism, for temporarily opposing the output voltage of the second tachometer, and thereby slowing down the transfer conveying means to a predetermined minimum speed which is much below the modified speed thereof.

4. Apparatus according to any one of Claims 1 to 3, wherein vacuum means are provided within said collecting drum and tapes are provided running at the speed of the collecting drum and having active runs bearing in part against the collecting drum, for holding the collected sheets on the drum, said transfer drum providing the drive for co-operative tapes whose active runs bear in part against the transfer drum and in part extend beyond the transfer drum for holding the sheet packets on the transfer drum and for conveying the sheet packets from the transfer drum to a controllable height sheet stacking table.

5. Apparatus according to any one of Claims 1 to 4, wherein said sheet conveying means includes a sheet cutter which is fed sheet material in web form by a web material conveying means, said cutter, said web conveying means and the collecting drum having a common driver, said collecting drum being connected to said cutter by power transmitting means for operation at identical rotary speeds and in fixed relation to the common driver, and a positive change speed transmission unit is interposed between the common driver and the web conveying means which is settable to control the length of web fed during a cutter cycle.

6. Apparatus according to any one of Claims 1 to 5, wherein a transfer flipper is provided normally confining the accumulated sheets to the collecting drum, and a counter is provided which counts the sheet delivered to form a packet on the collecting drum, said transfer flipper being shiftable to a stripping position by a shifting mechanism

which is responsive to a predetermined count of the counter, thereby causing the packet to be fed as a unit onto the transfer drum.

7. Apparatus according to Claim 1 or 2, wherein said variable speed drive mechanism comprises variable speed gearing constantly connecting the transfer conveying means with the collecting drum.

8. Apparatus according to any one of Claims 1 to 7, wherein said sheet conveying means includes an inspecting means constructed and arranged automatically to scan each sheet length as it is advanced at high speed and to develop no classification signal if a sheet length falls in the category of first quality, but to develop distinctive classification control signals for sheet categories of unacceptable quality and of acceptable quality other than first quality, and a plurality of collecting drums and transfer drums are provided, one in each collector unit of a sorting means, said sorting means including a receiver for the unacceptable sheets, and a plurality of collecting units for the respective categories of acceptable sheets.

9. Apparatus according to Claim 8, wherein a delay mechanism is provided effecting a delayed transmission of classification signals from the inspection means to the sorting means in timed relation with the arrival at the sorting station of the sheets responsible for the respective signals.

10. Apparatus according to Claim 8 or 9, wherein a sorting flipper is associated with each of said collectors, the sorting flipper associated with the collector of first quality sheets being normally open, said sorting flipper being temporarily closed at a proper time and for a sufficient period by closing means in response to each classification control signal denoting a lower acceptable category so as to cause the sheet responsible for said signal to be excluded, the sorting flipper associated with a collector of a lower category of acceptable sheets being normally closed, but being temporarily opened at a proper time and for a sufficient period by opening means in response to the classification control signal of that category so as to cause the sheet responsible for said signal to be accepted.

11. Apparatus according to Claim 4, wherein the stacking table height is controlled by a photoelectric relay viewing, by reflected light, the top edge of a stack of paper on which the packets are received to automatically lower the stacking table when the stack level exceeds a selected stacking level, said stacking table further being equipped with air jets for separating the

sheets in the packets received by the stacking table, and jogger mechanisms are provided for bringing the sheets separated by the air jets into exact registry with each other to form a stack, the air between the sheets being pressed out by tamping means.

12. The method of inspecting, cutting, sorting and delivering sheets of paper when used in connection with the apparatus according to Claims 1 to 11, wherein the steps are provided of advancing a single web of paper at constant speed successively past an inspection station and a sheet cutting station, scanning each sheet length of the web as it passes the inspection station to determine the quality thereof while developing classification signals characteristic of any significant defects, cutting successive sheets of predetermined, uniform length from the leading end of the traveling web at the cutting station, continuing the advance of the sheets at undiminished speed along a path which includes a plurality of sorting stations, separating the sheets of first quality at one sorting station, separating the sheets of second quality at another sorting station, and conveying the separated sheets away from each sorting station at smoothly diminishing speed and finally discharging them at a delivery station at a final delivery speed which is only a small fraction of the speed at which they were traveling during cutting.

13. The method of cutting and delivering sheets of paper when used in connection with the apparatus according to Claims 1 to 7, wherein the steps are provided of advancing a single web of paper at constant speed to a cutting station, cutting successive sheets of predetermined, uniform length from the leading end of the traveling web, continuing the advance of the sheets at undiminished speed to a collecting station, collecting successive sheets at the collecting station in a registered packet of a predetermined number of sheets, delivering the packet at undiminished speed for at least a packet length and thereafter at smoothly diminishing speed to a final delivery speed which is a small fraction of the collecting speed.

14. Sheet handling apparatus constructed and arranged substantially as described in the Specification with reference to Figs. 1 to 13 of the accompanying drawings.

15. The method of Claims 12 or 13 substantially as described in the Specification.

STEVENS, LANGNER, PARRY  
& ROLLINSON,

Chartered Patent Agents,  
Agents for the Applicants.

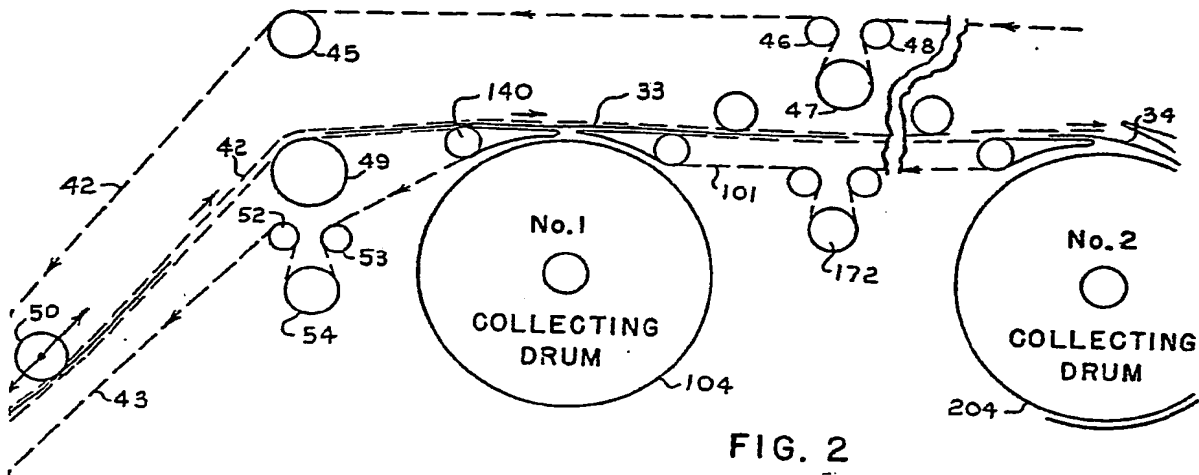
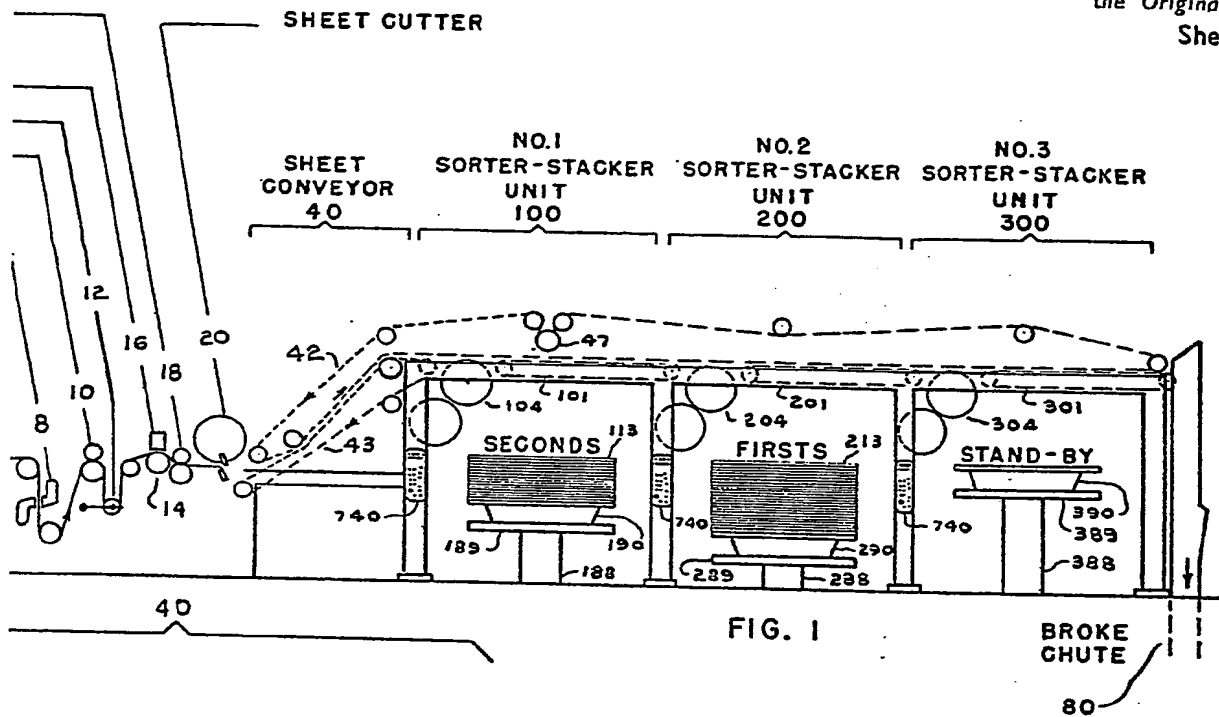
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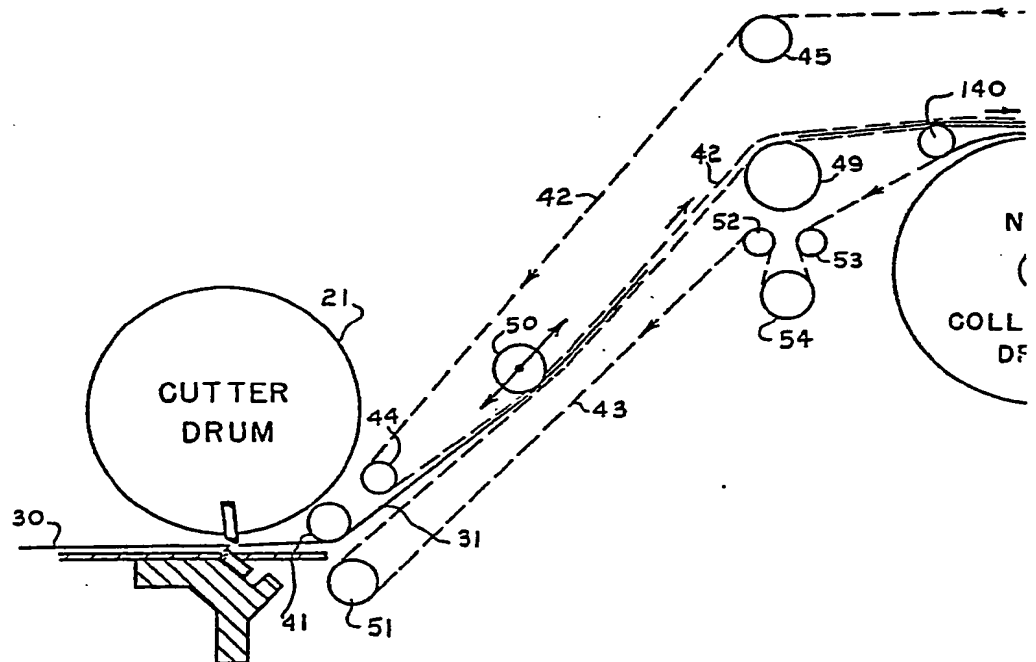
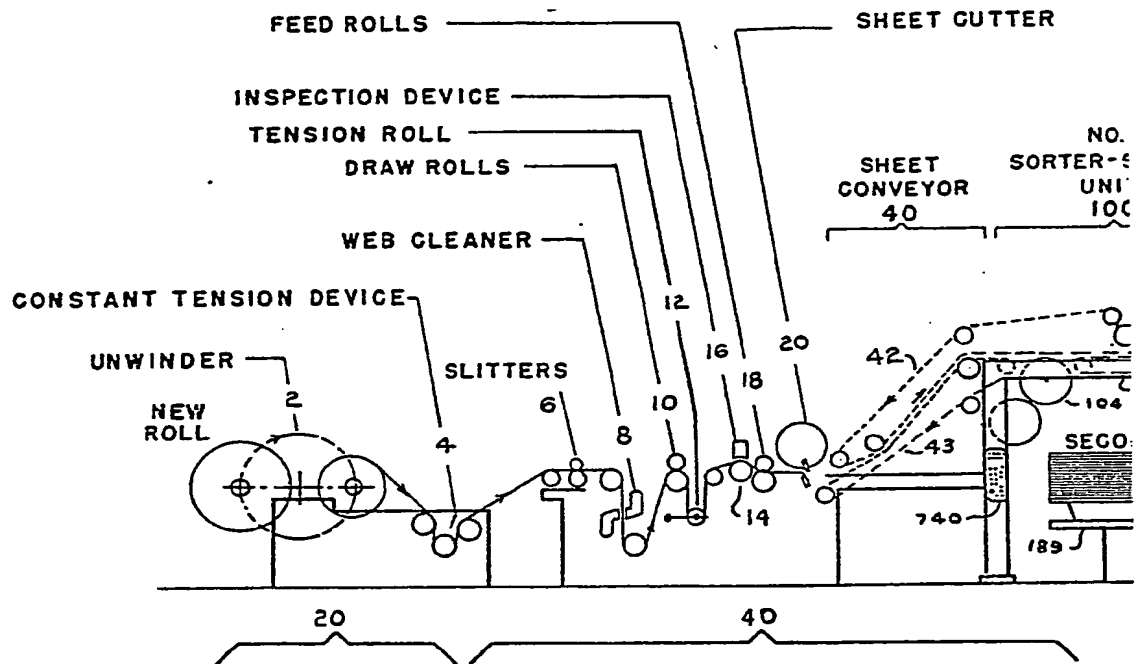
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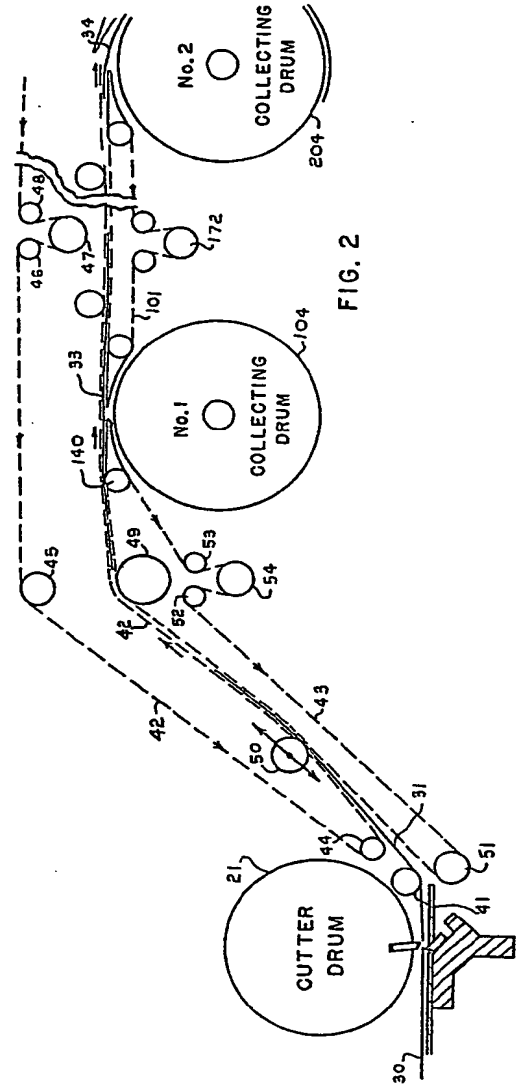
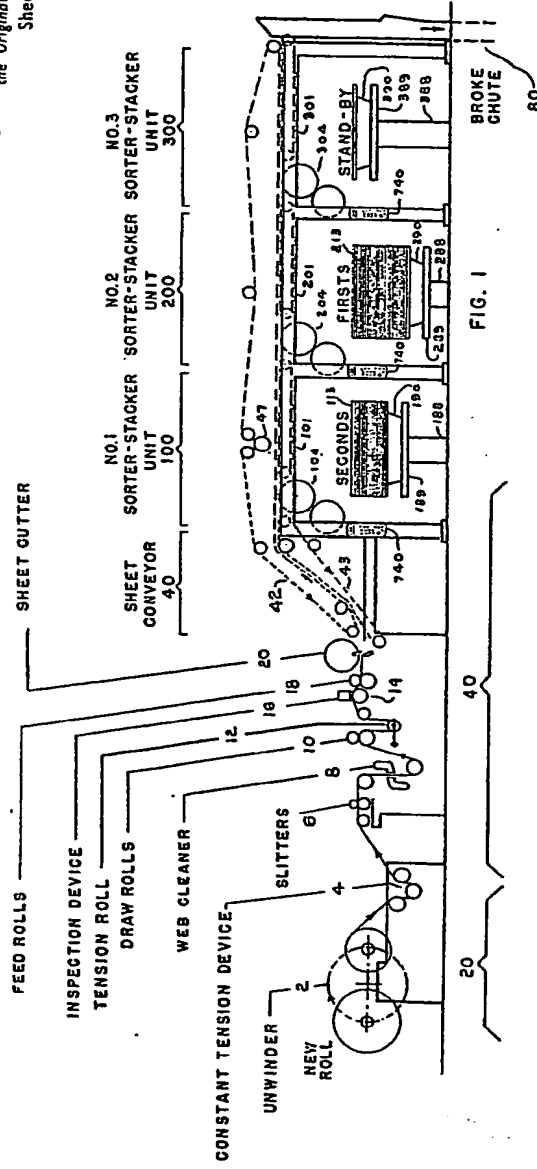
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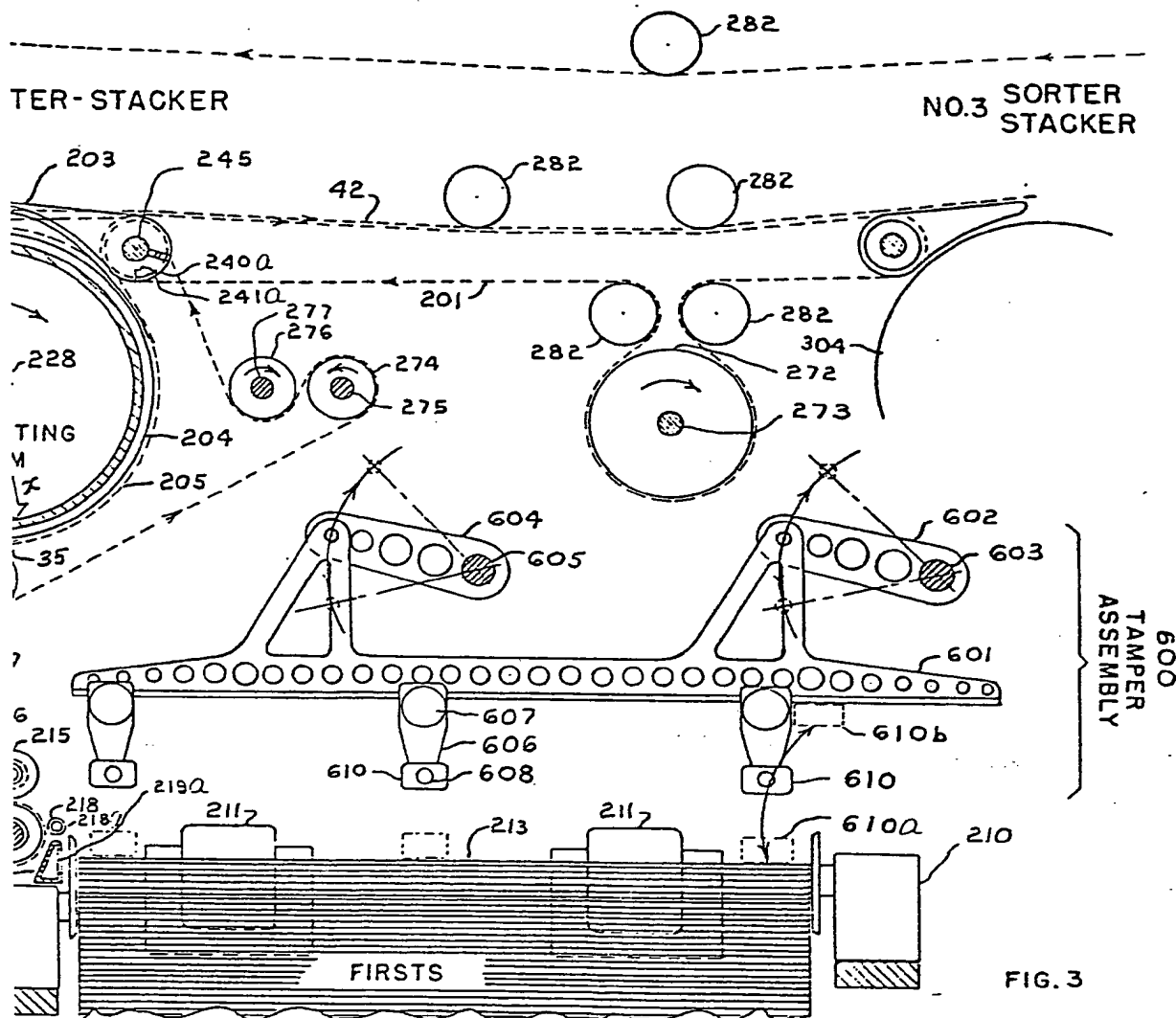


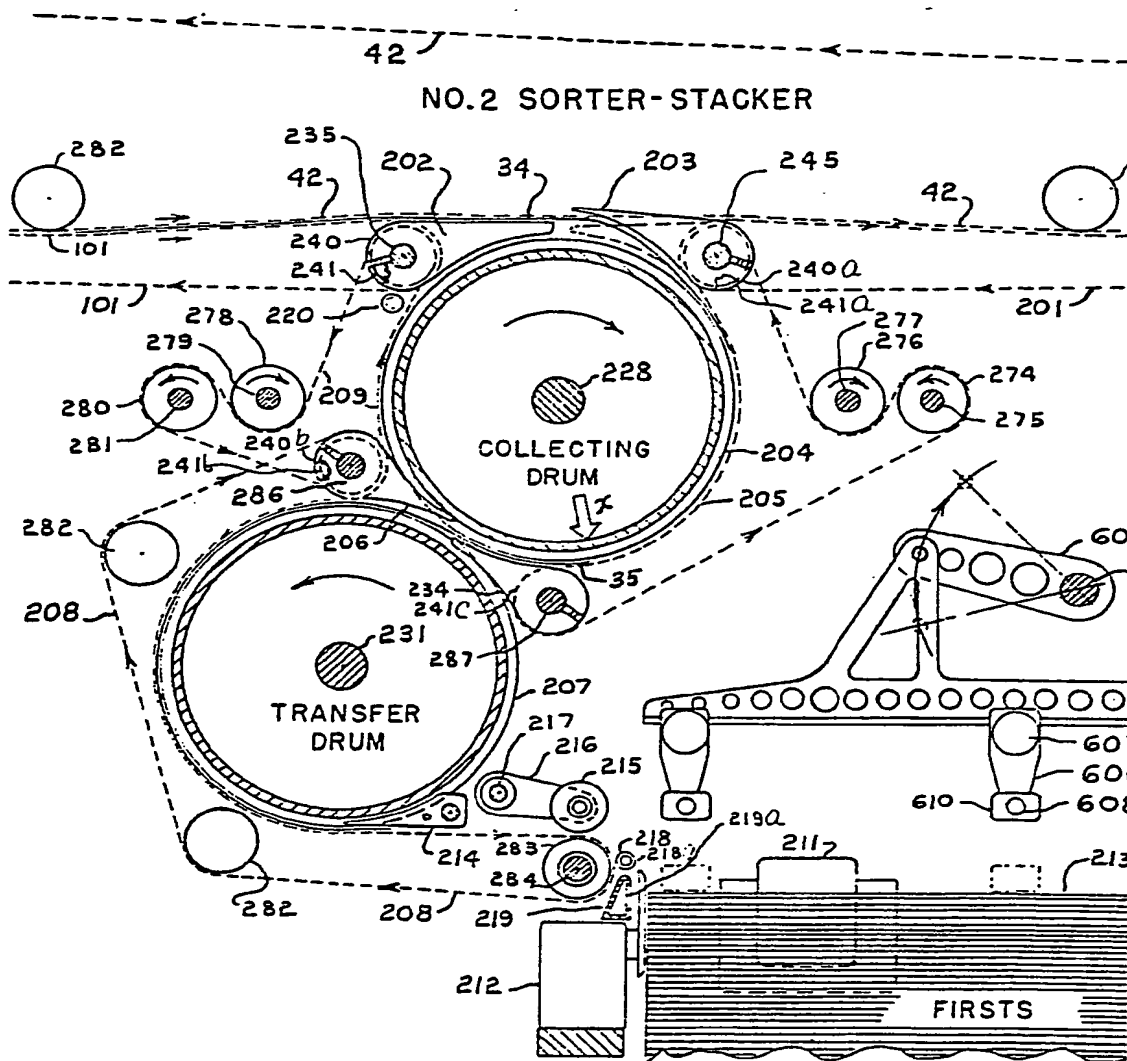
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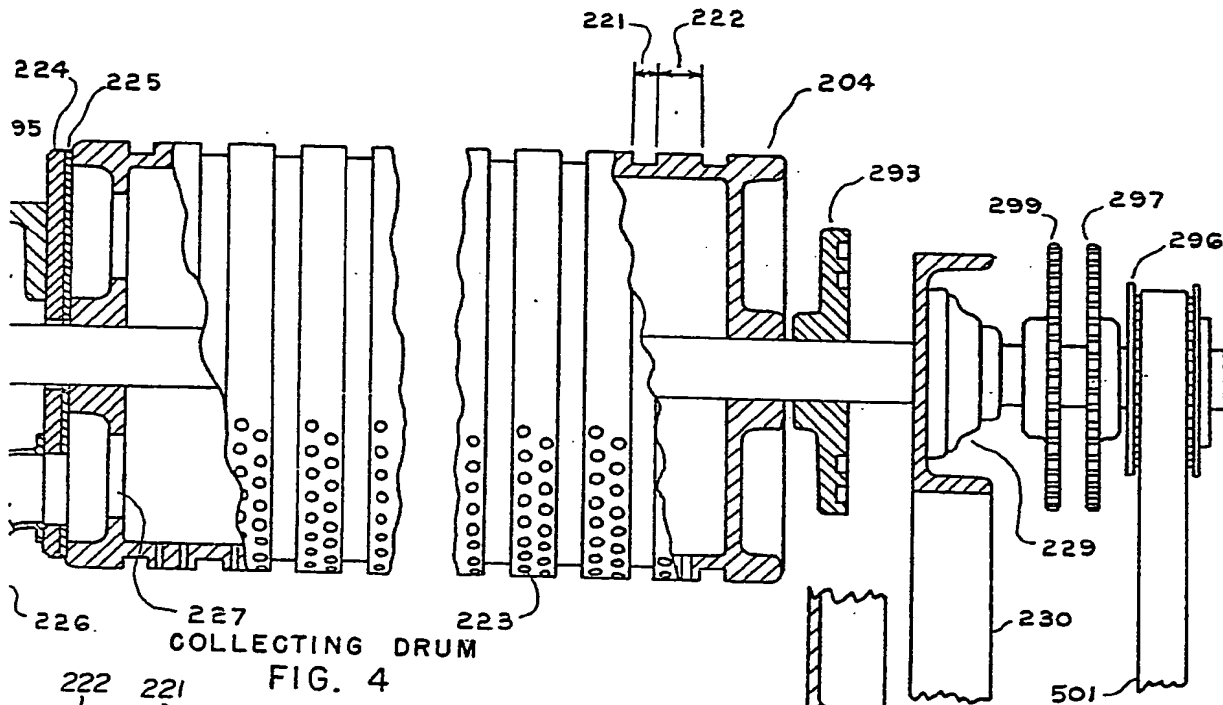
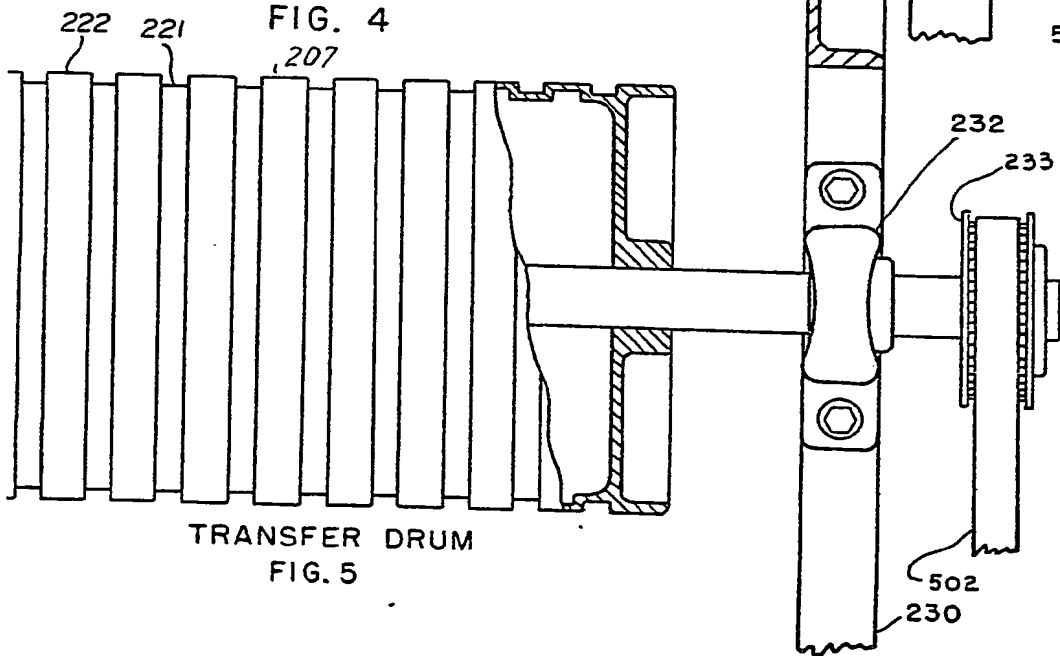
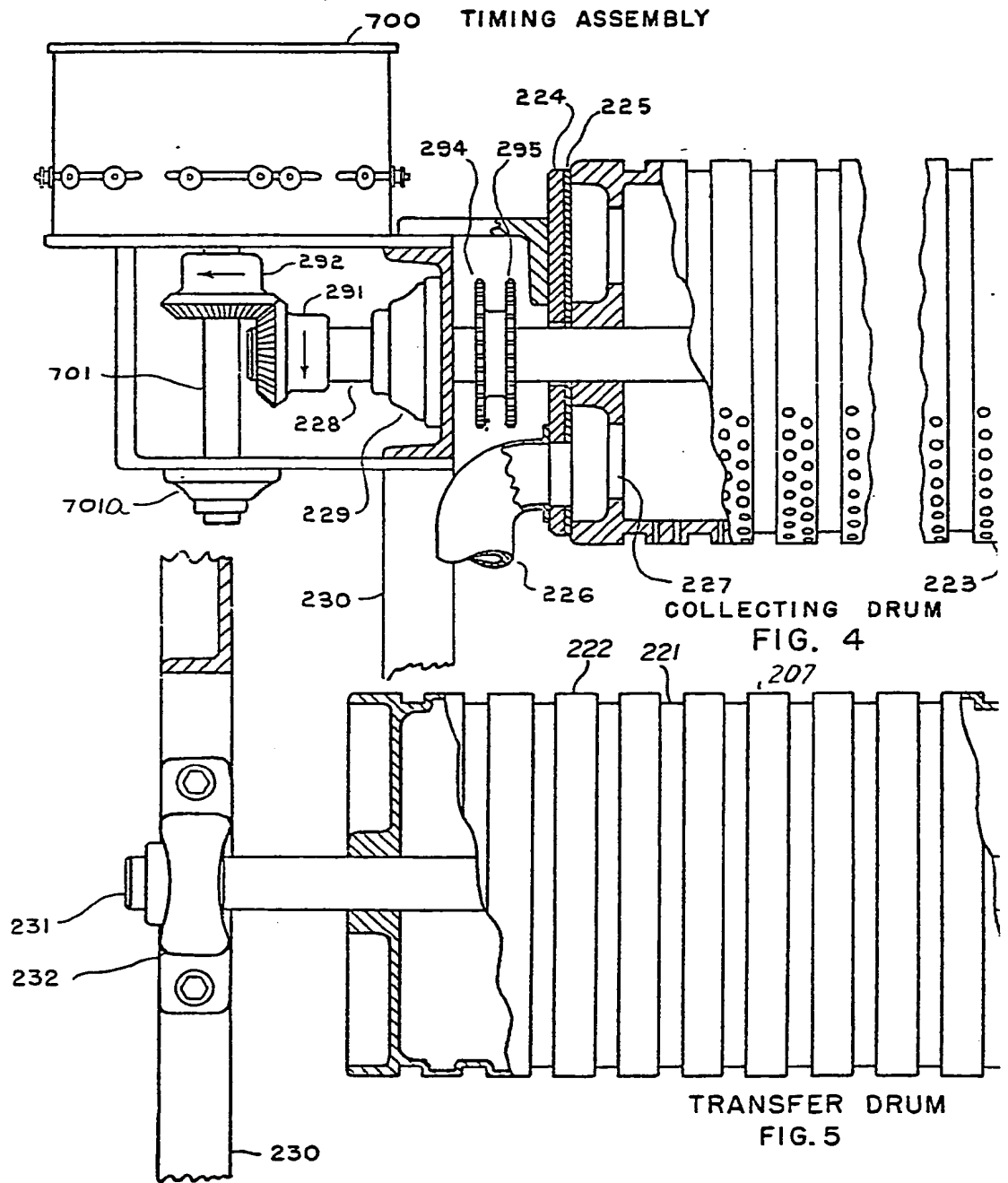
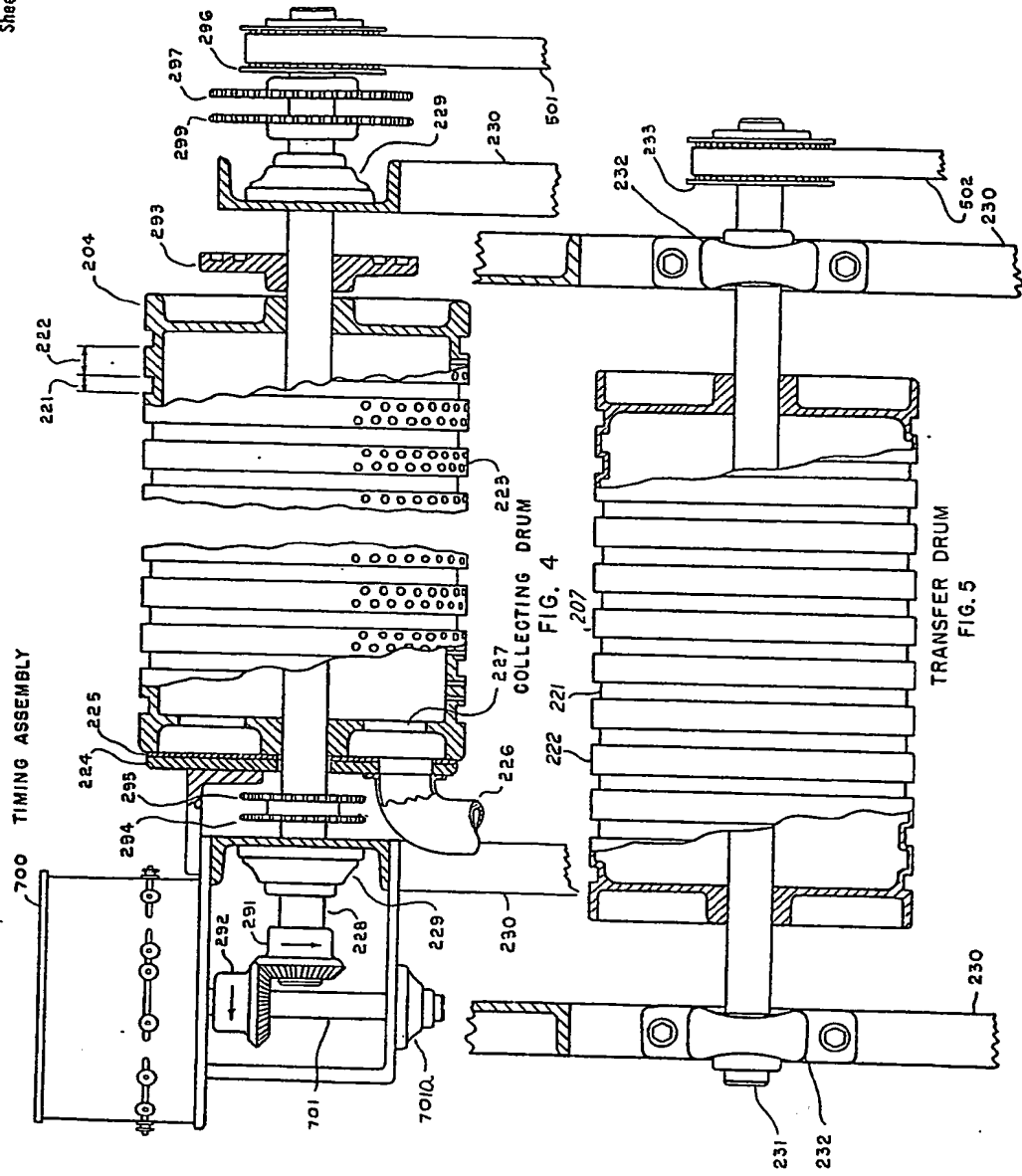


FIG. 4



TRANSFER DRUM  
 FIG. 5





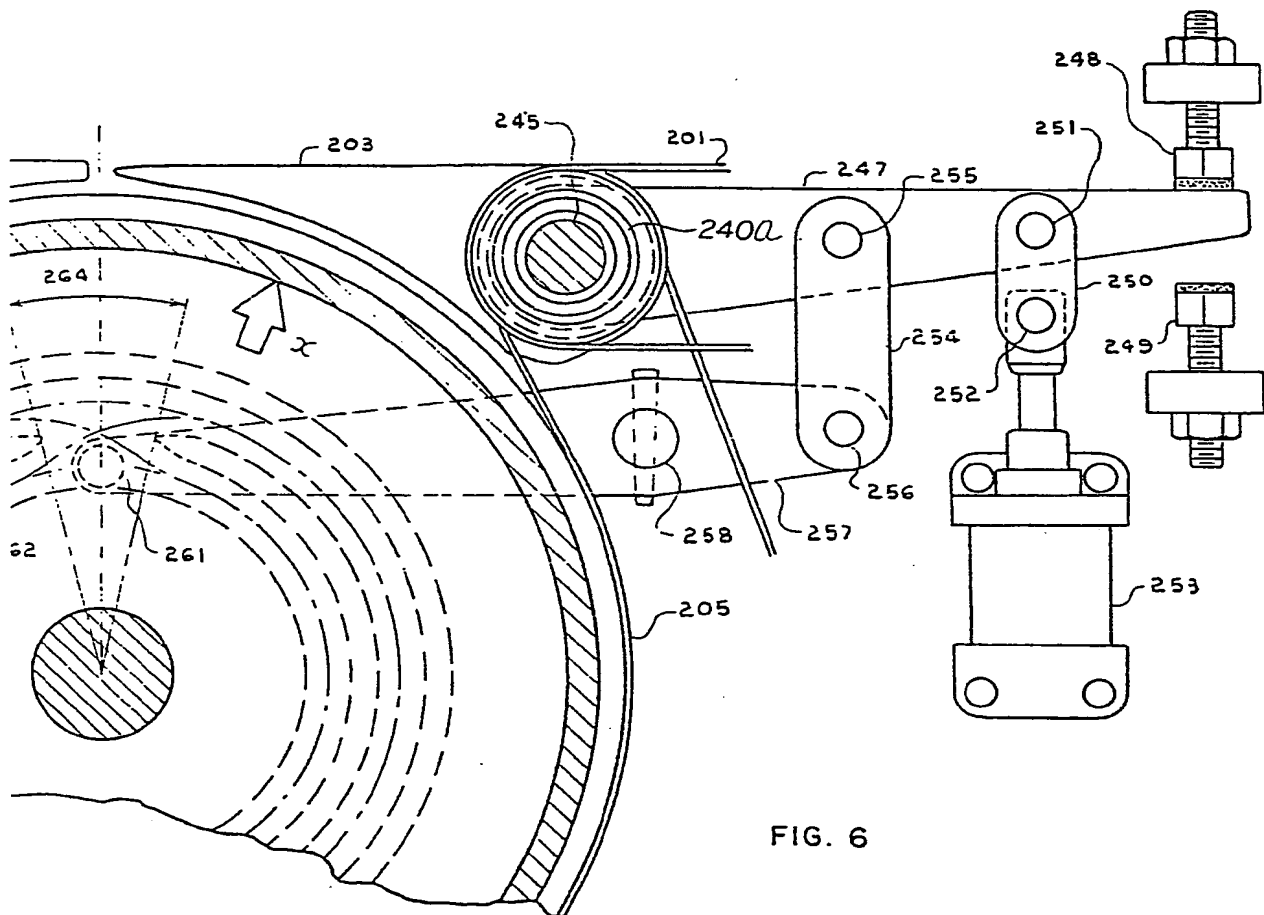
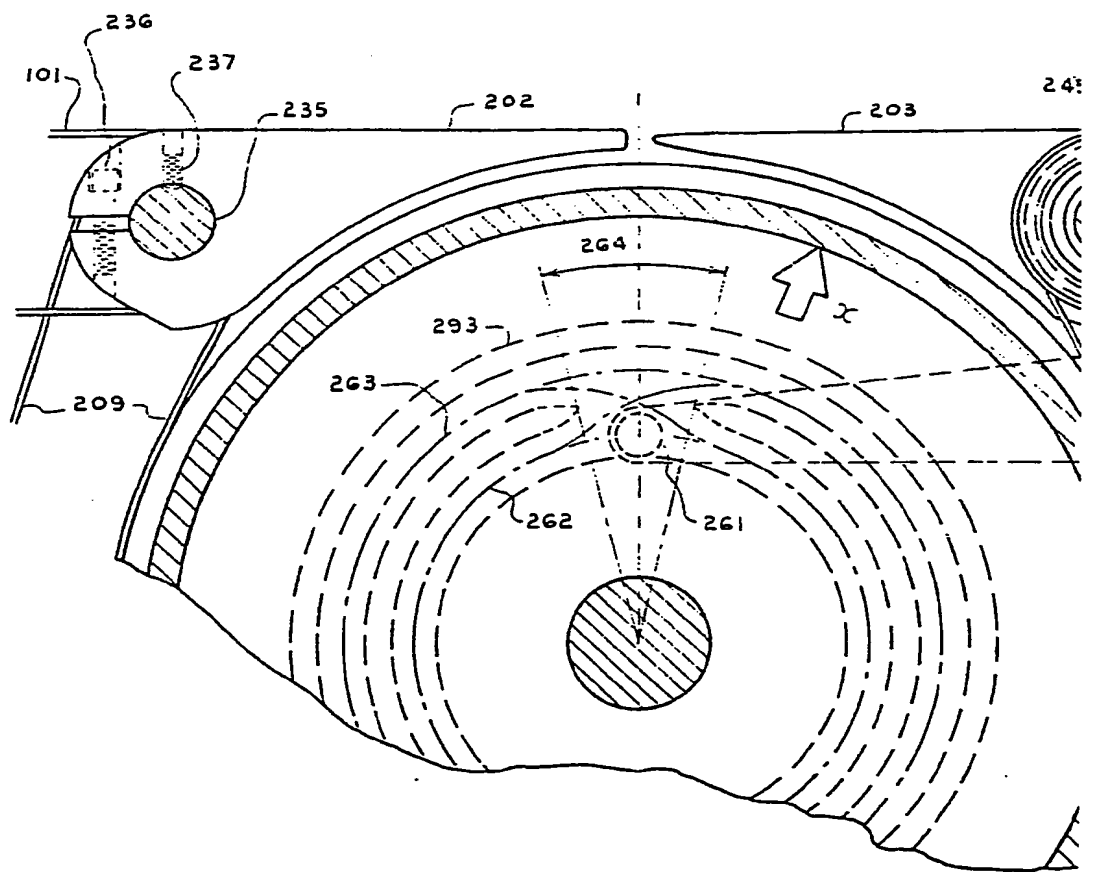


FIG. 6





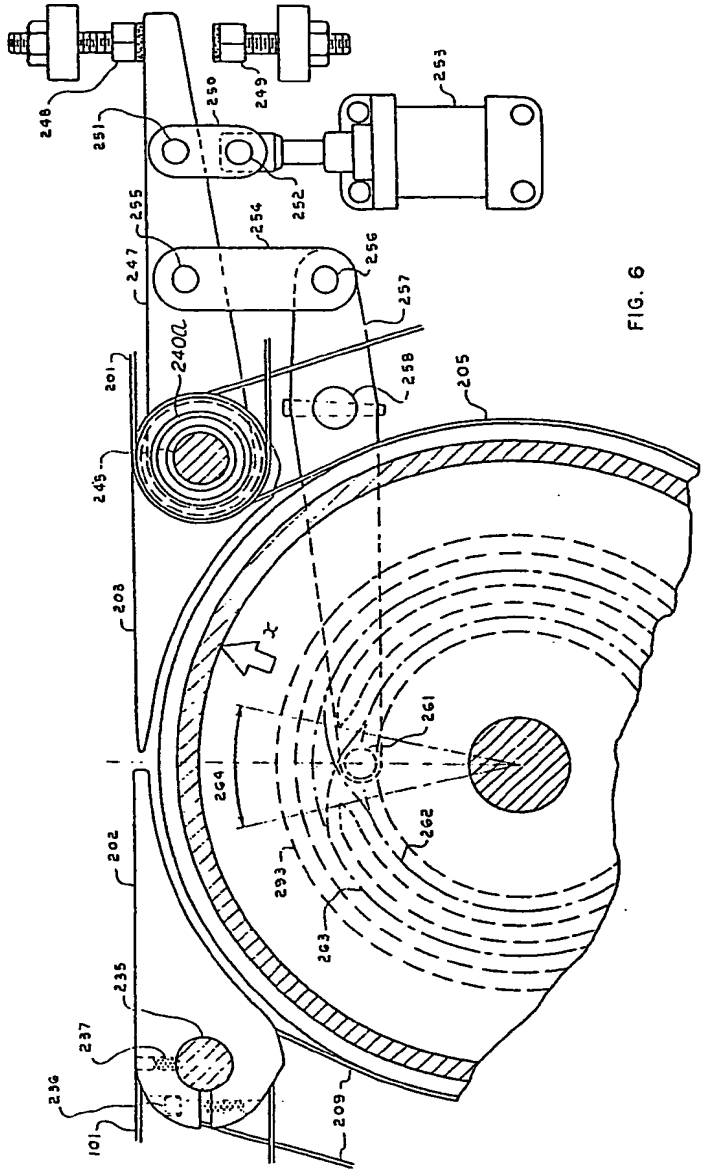
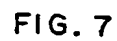


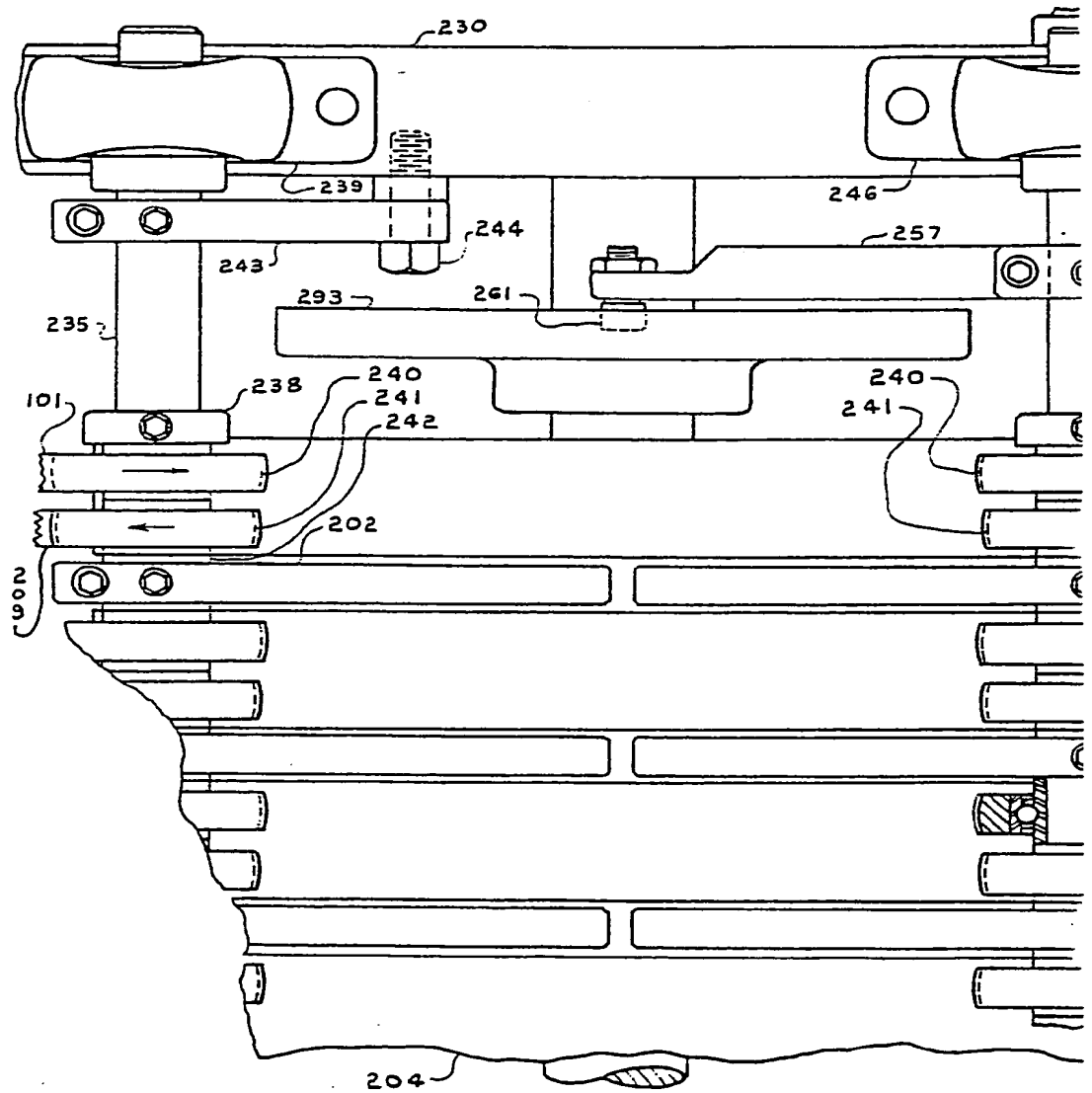
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Sheet 5**





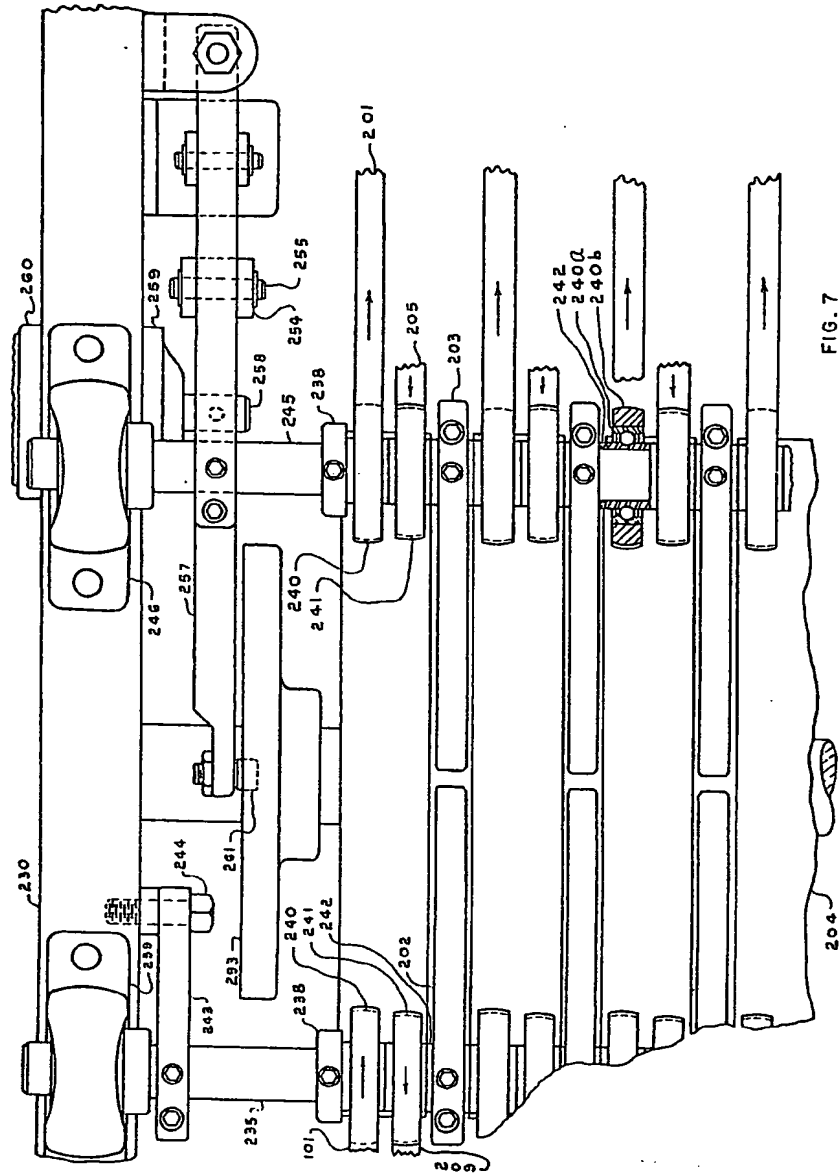


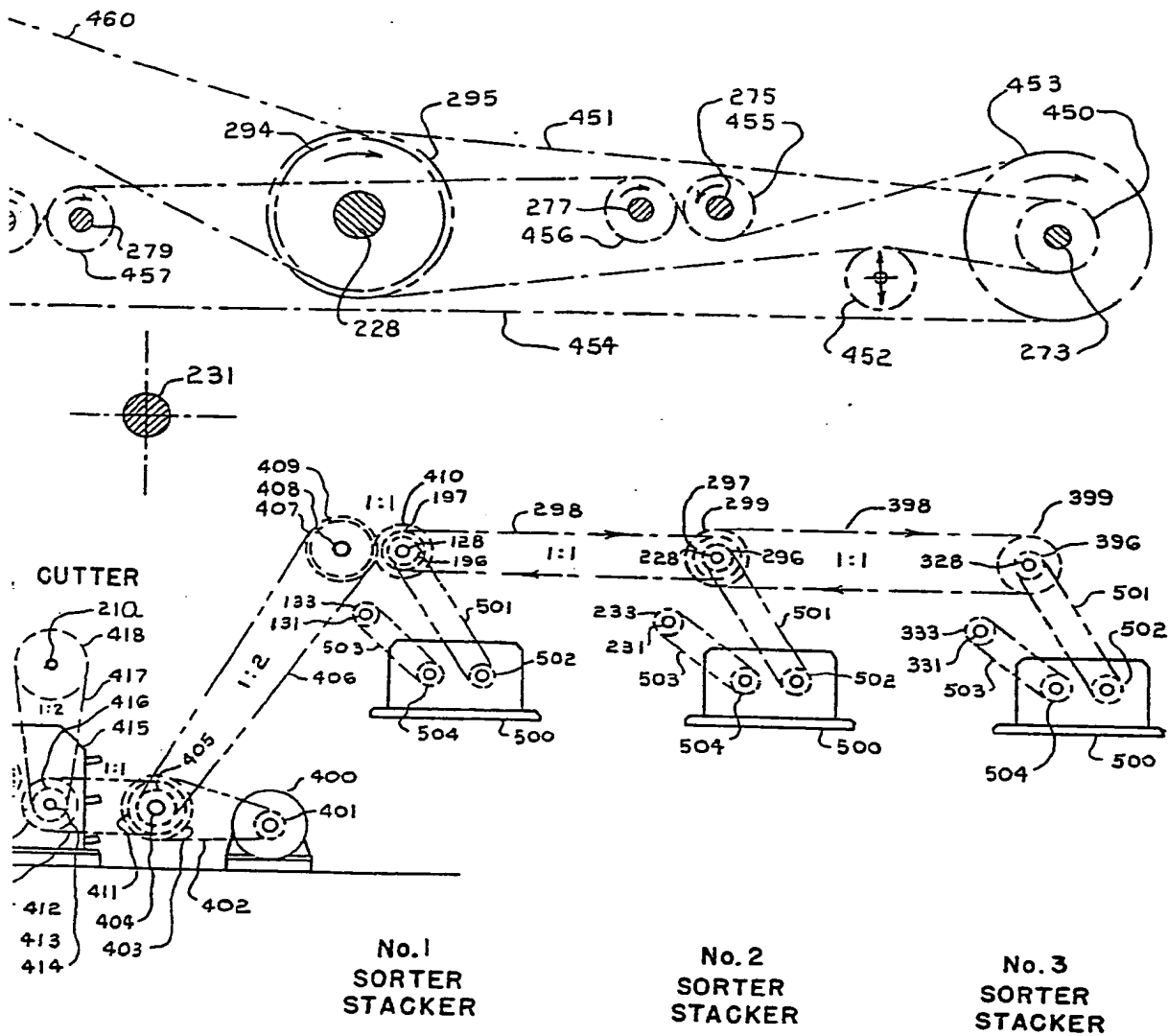
FIG. 7

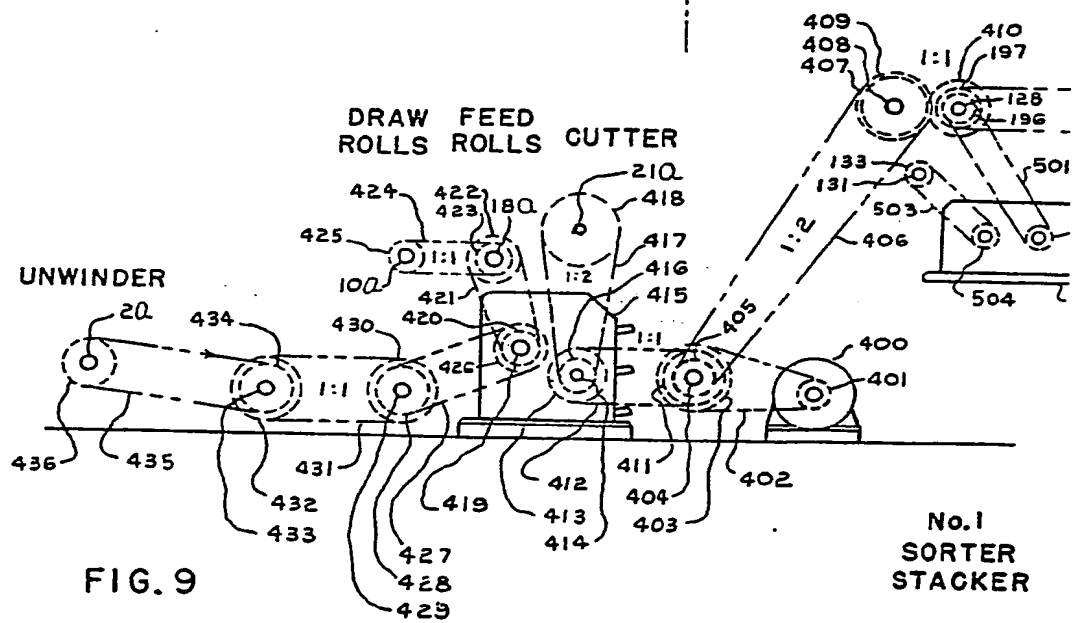
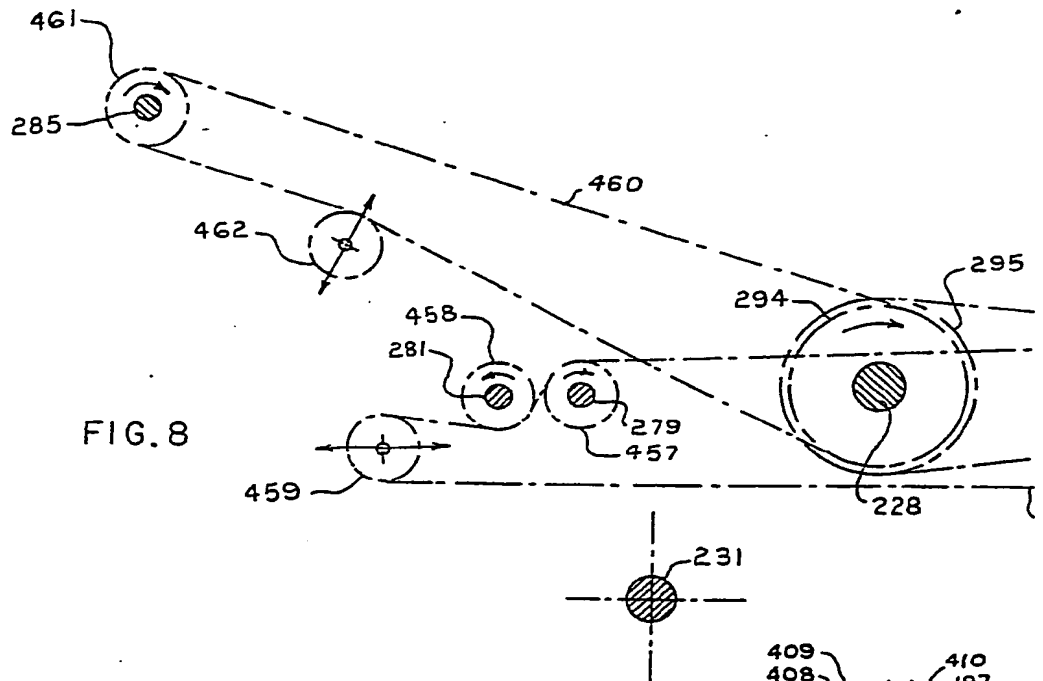
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COMPLETE SPECIFICATION

10 SHEETS

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Sheet 6





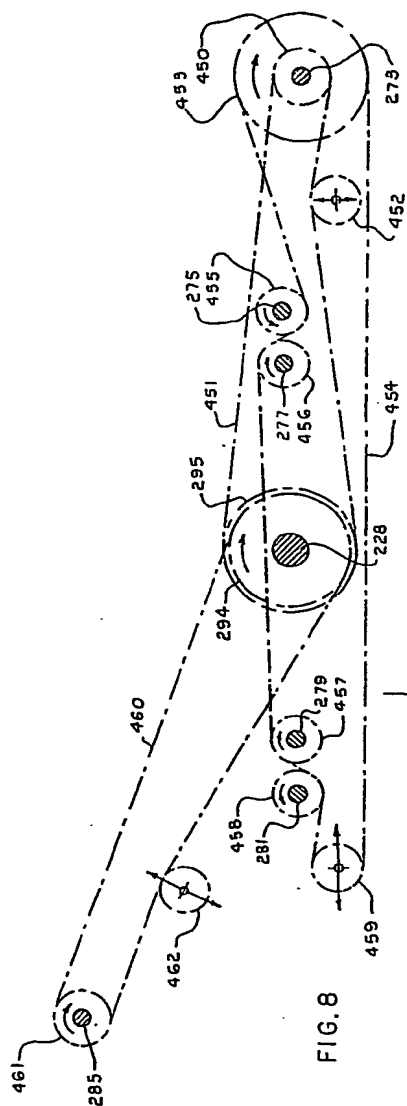


FIG. 8

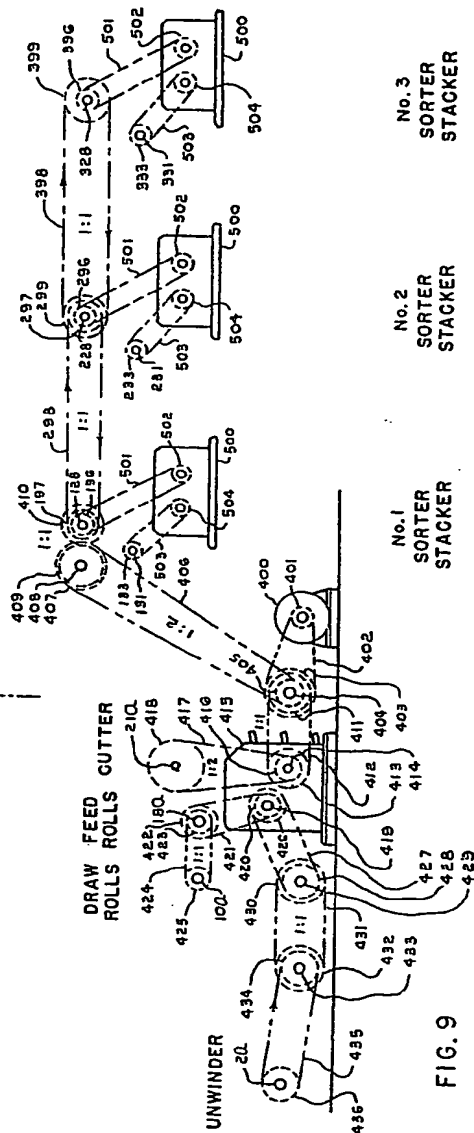


FIG. 9

No. 3  
SORTER  
STACKER

No. 2  
SORTER  
STACKER

No. 1  
SORTER  
STACKER

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10 SHEETS

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the Original on a reduced  
Sheet 7

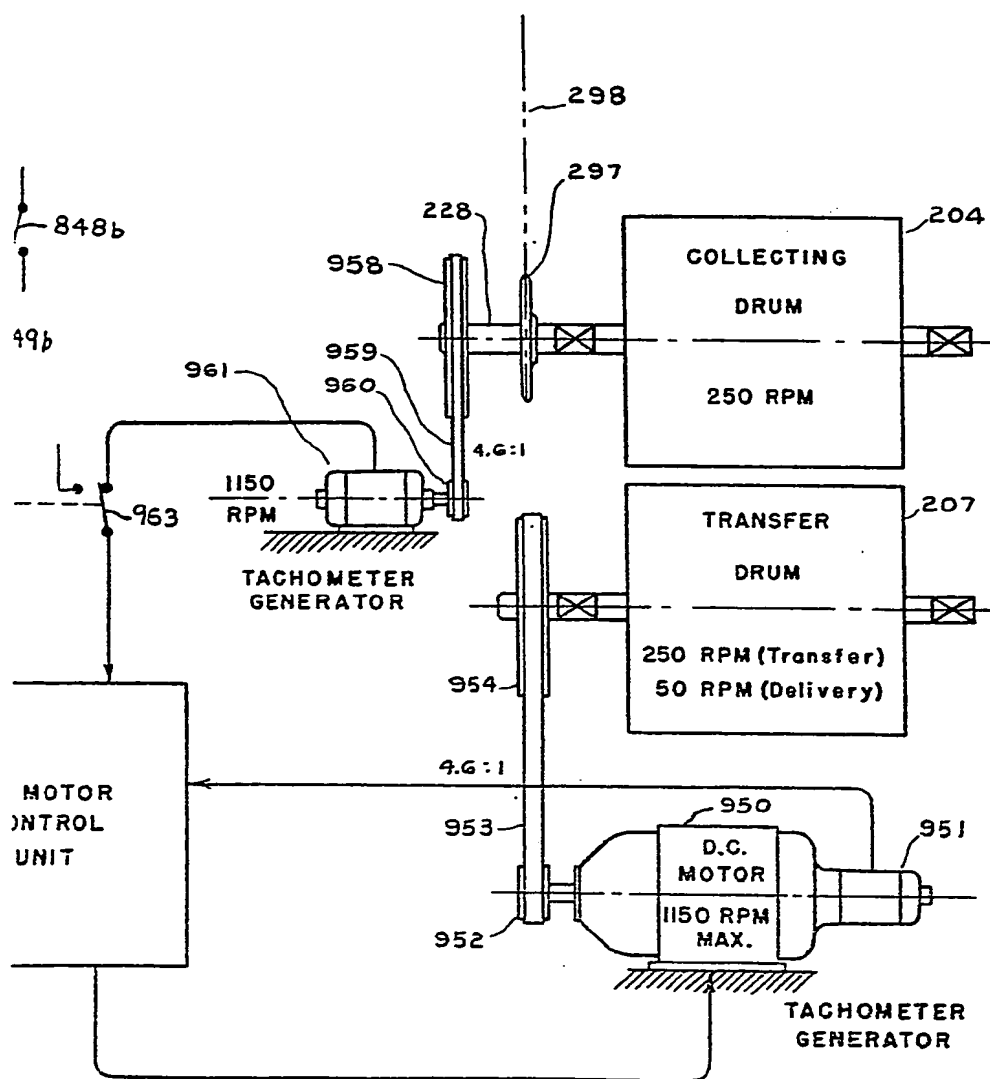


FIG. 10



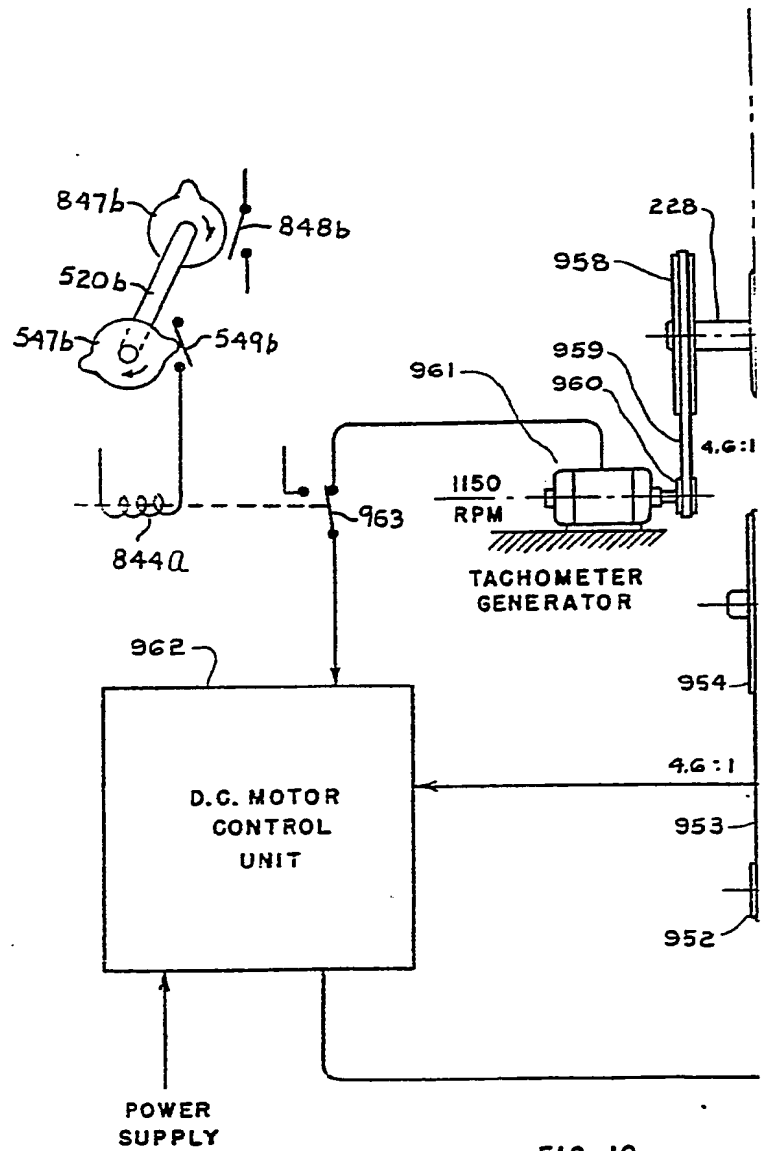


FIG. 10

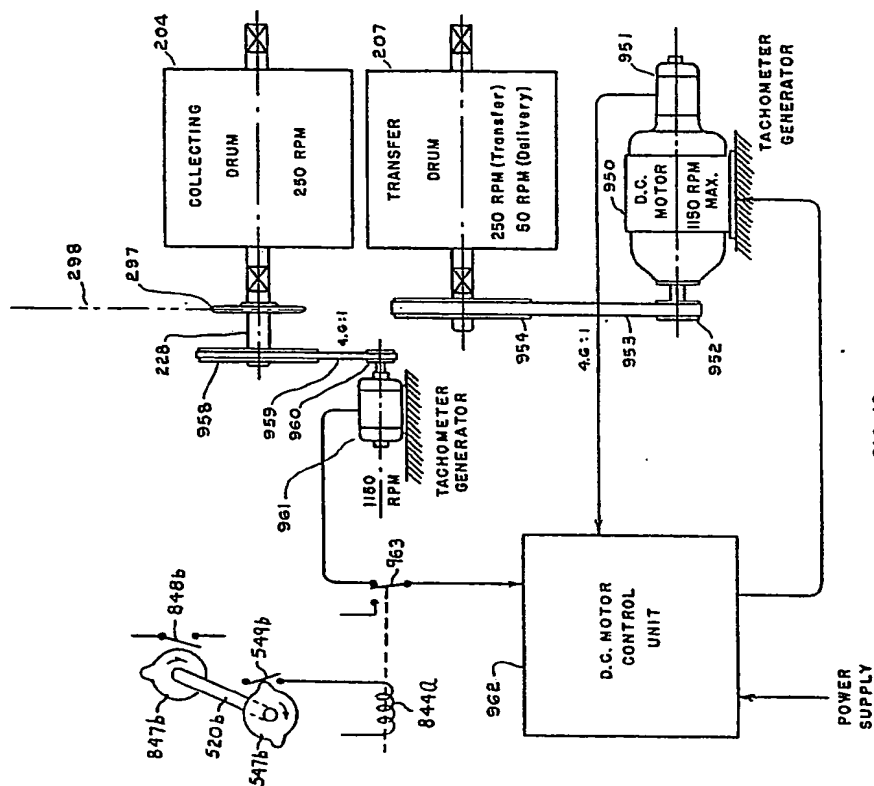


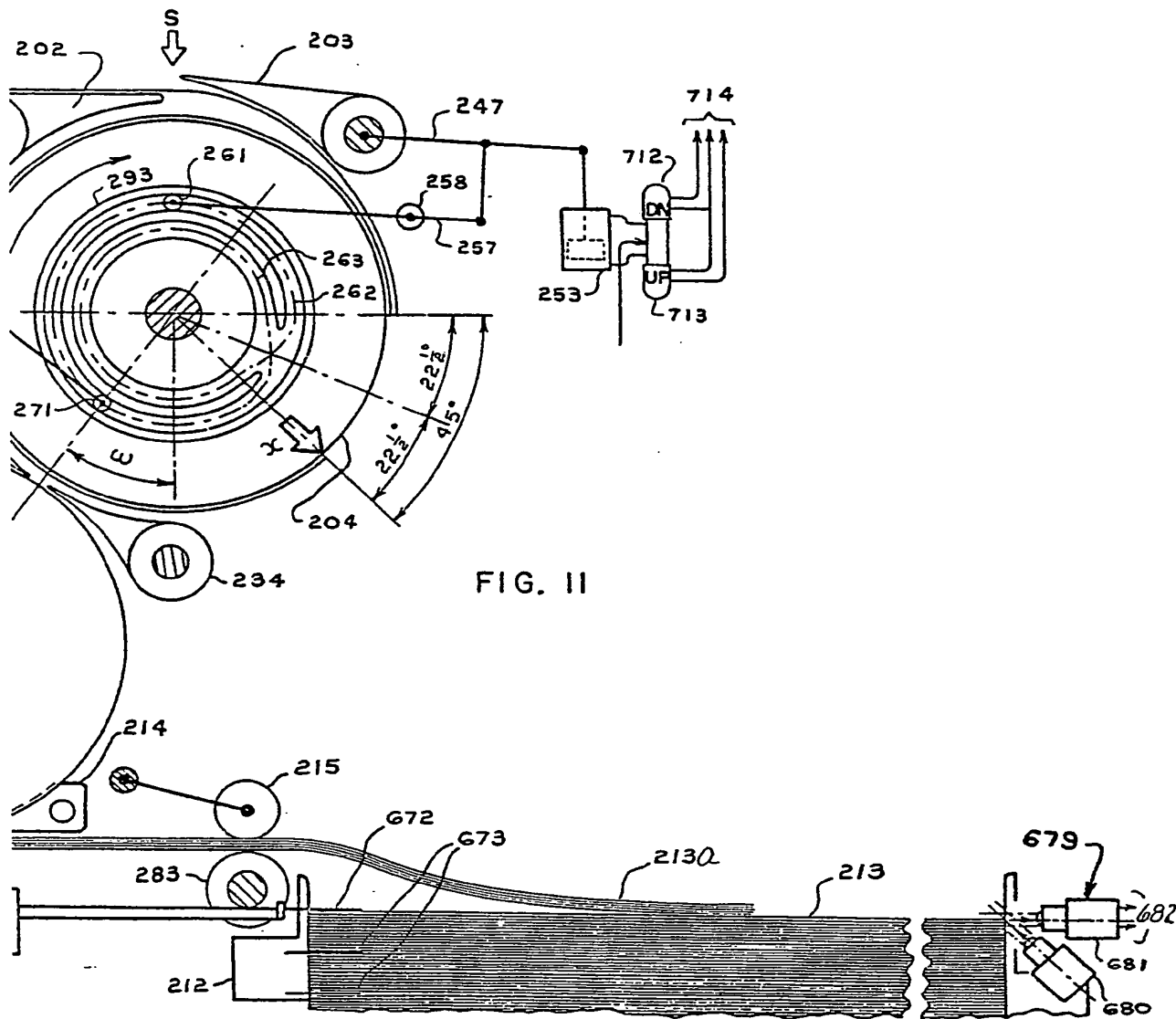
FIG. 10

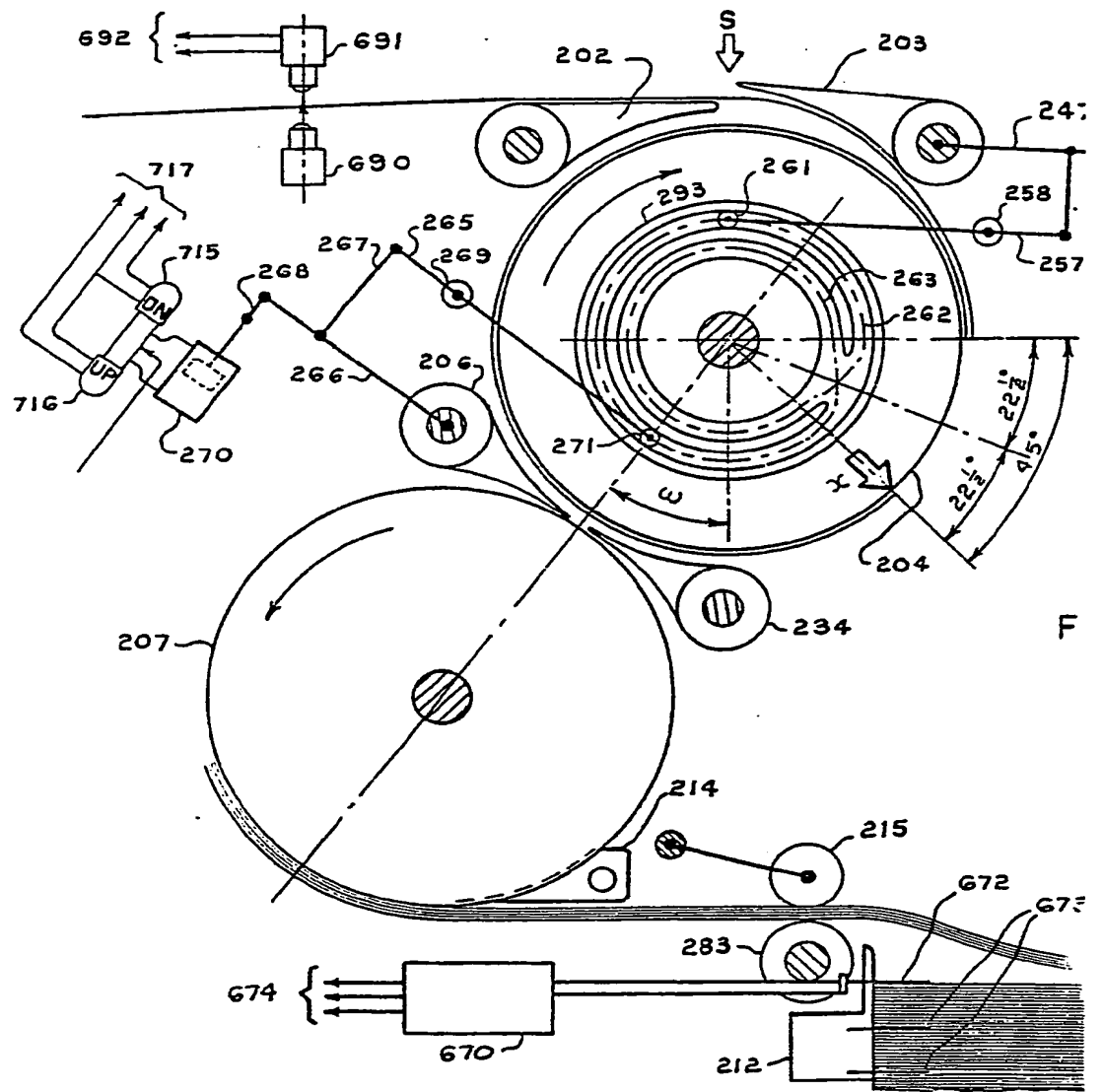
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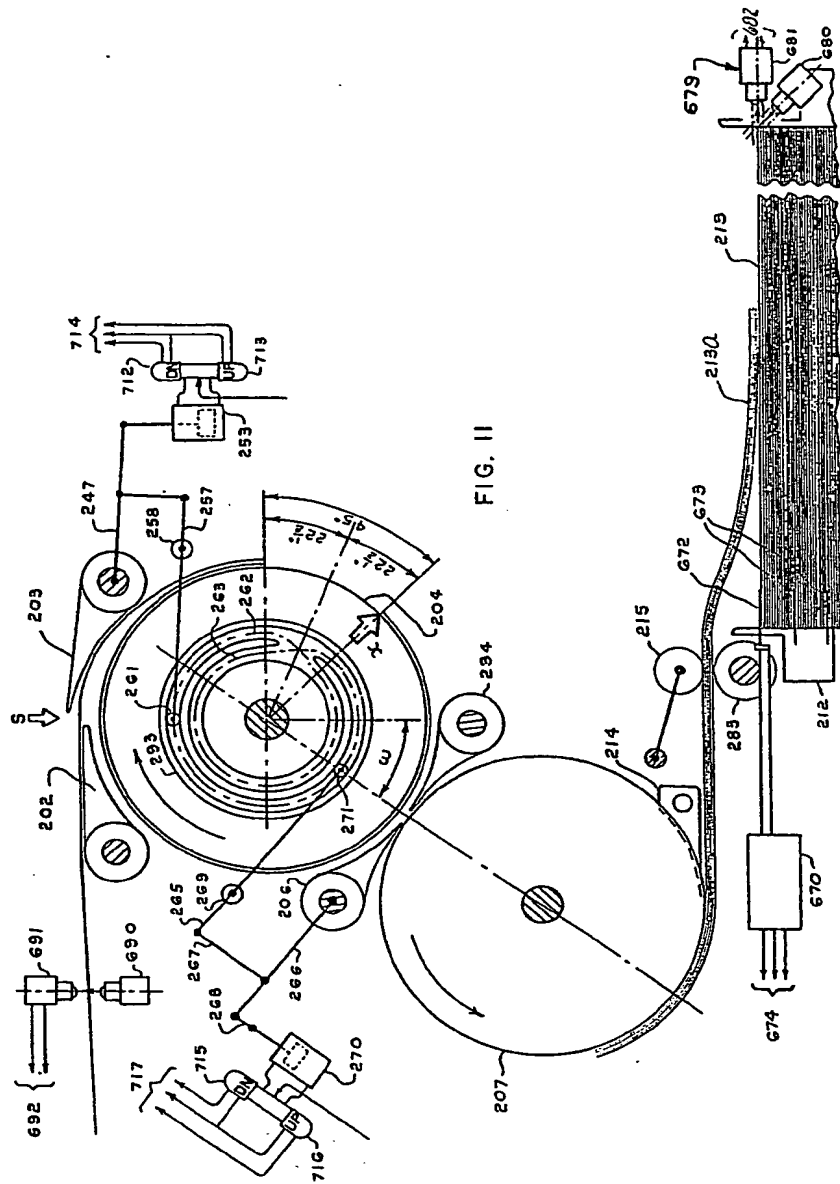


FIG. II

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COMPLETE SPECIFICAT

10 SHEETS

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Sheet 9

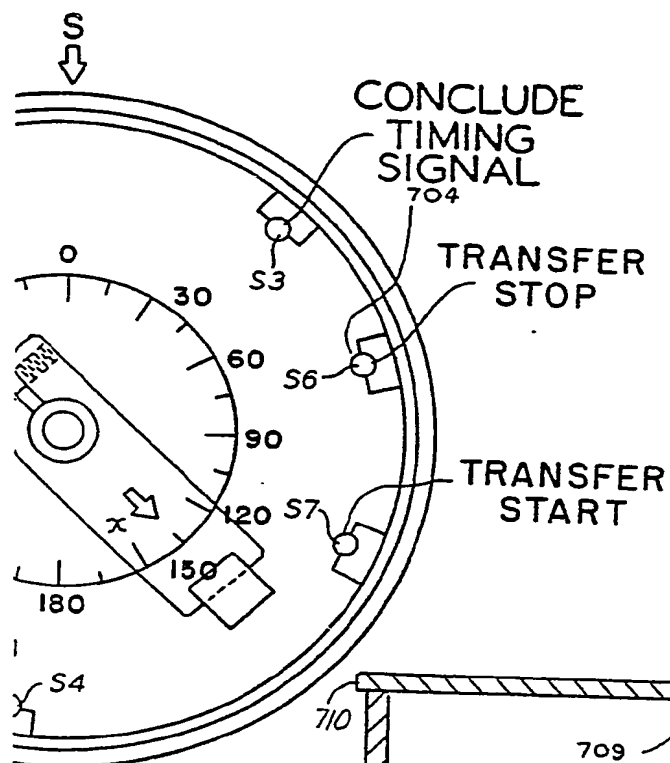


FIG. 12

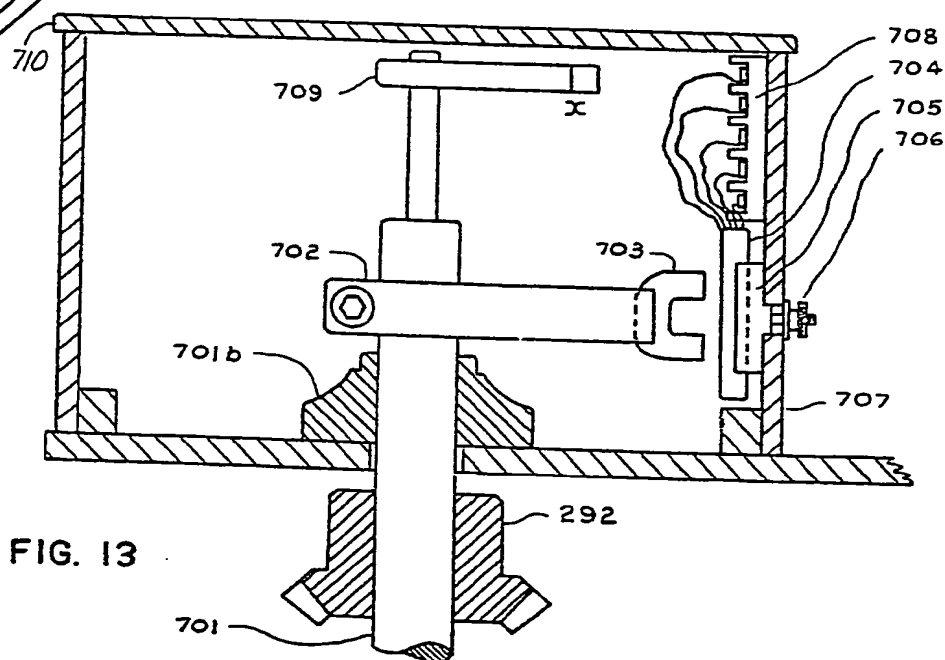


FIG. 13

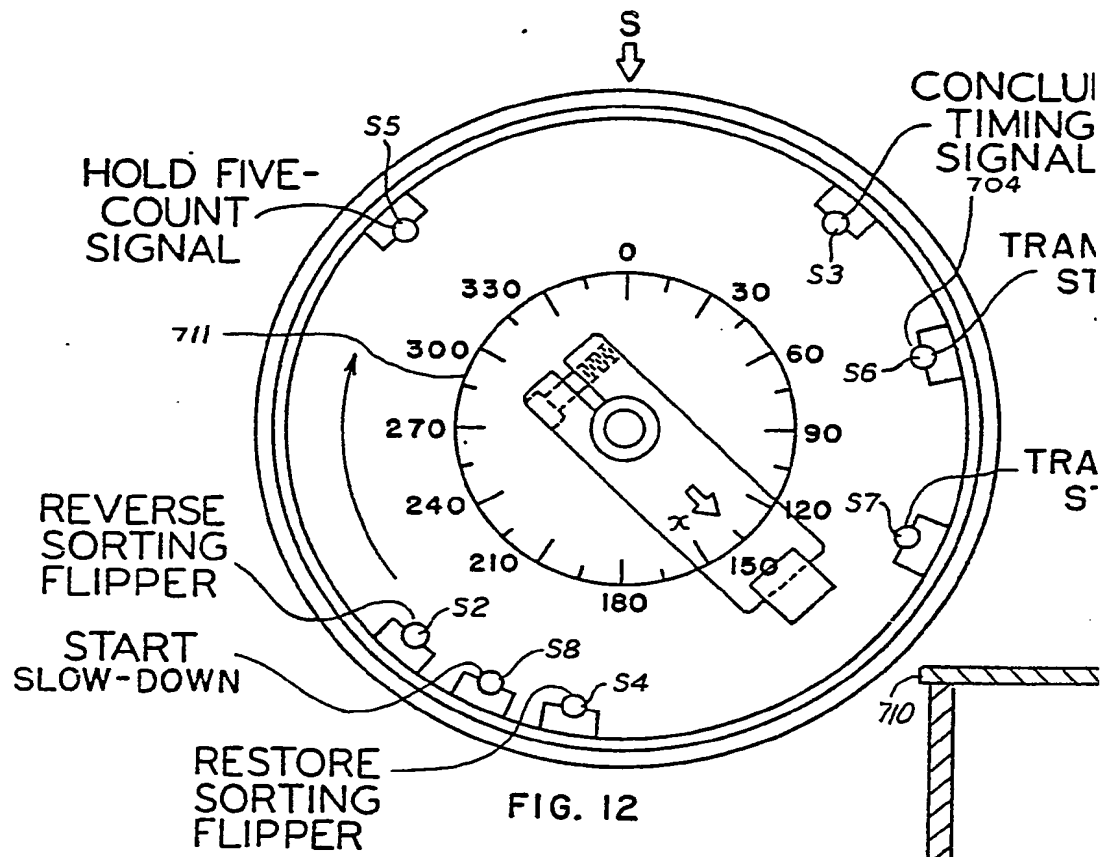


FIG. 12

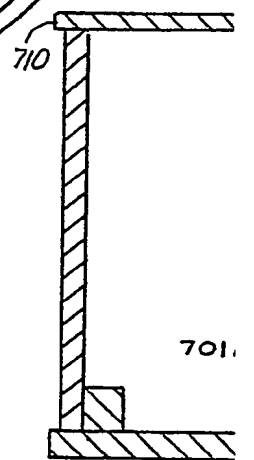


FIG. 13

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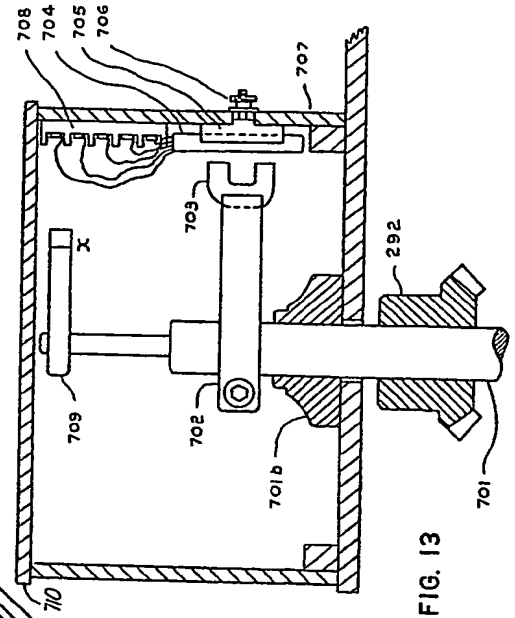
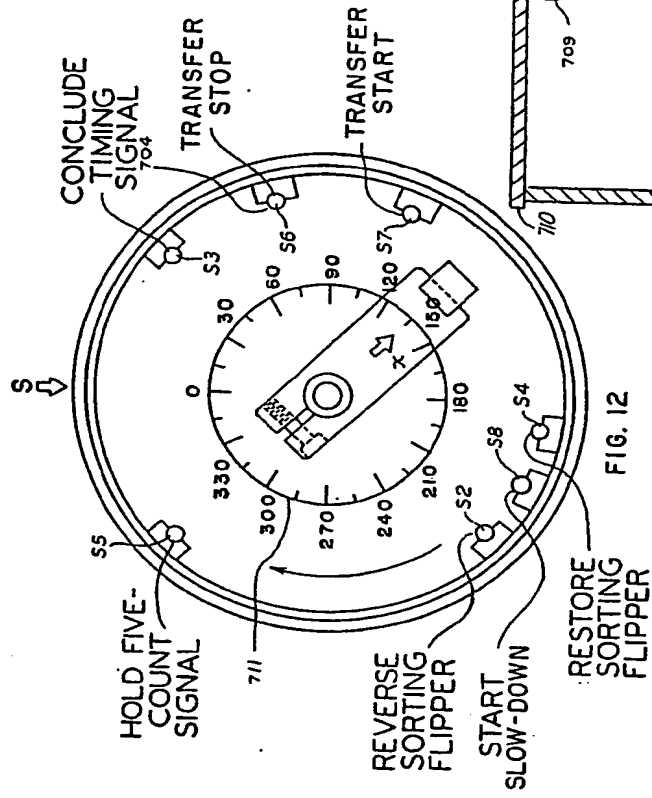


FIG. 13



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Sheet 10

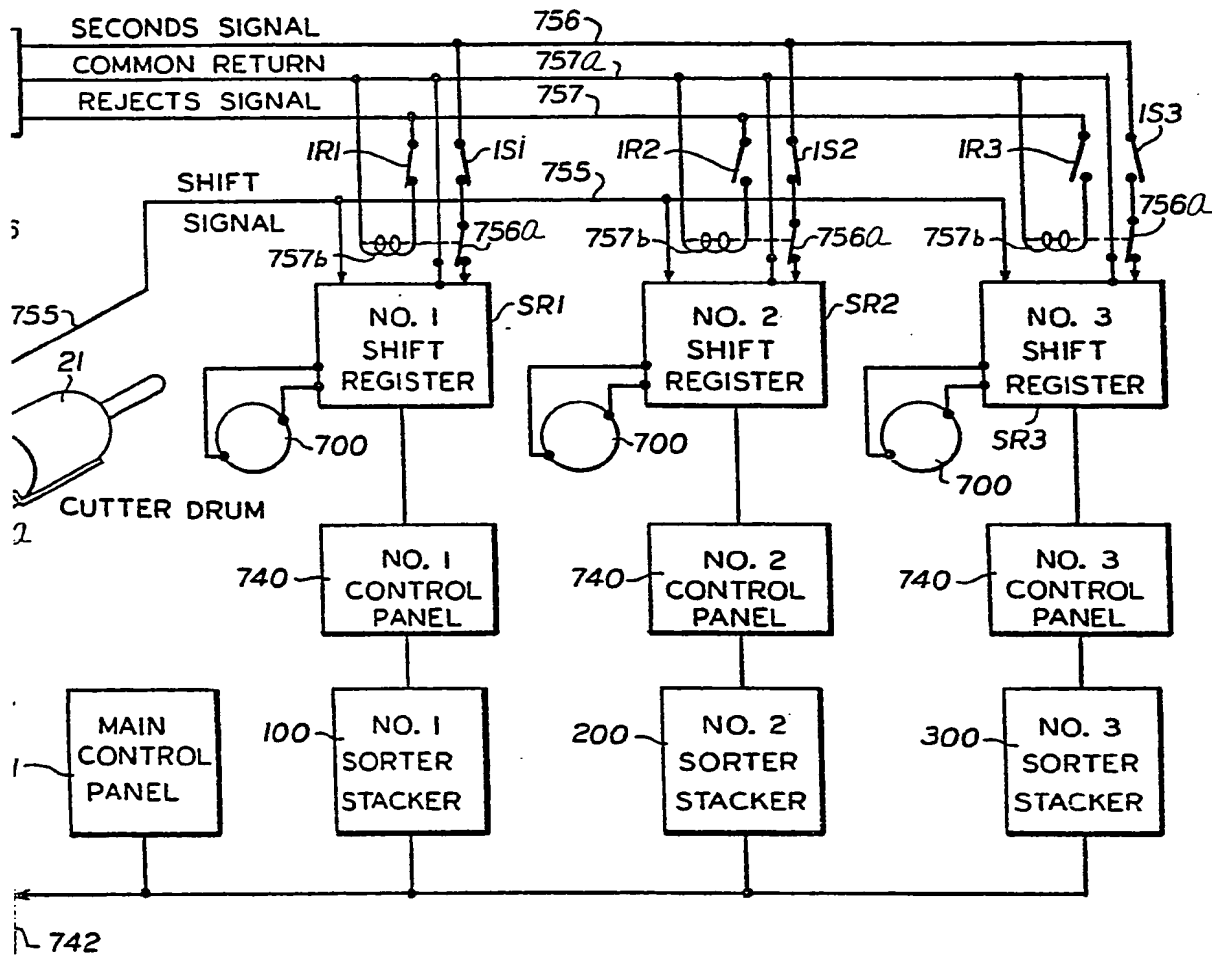
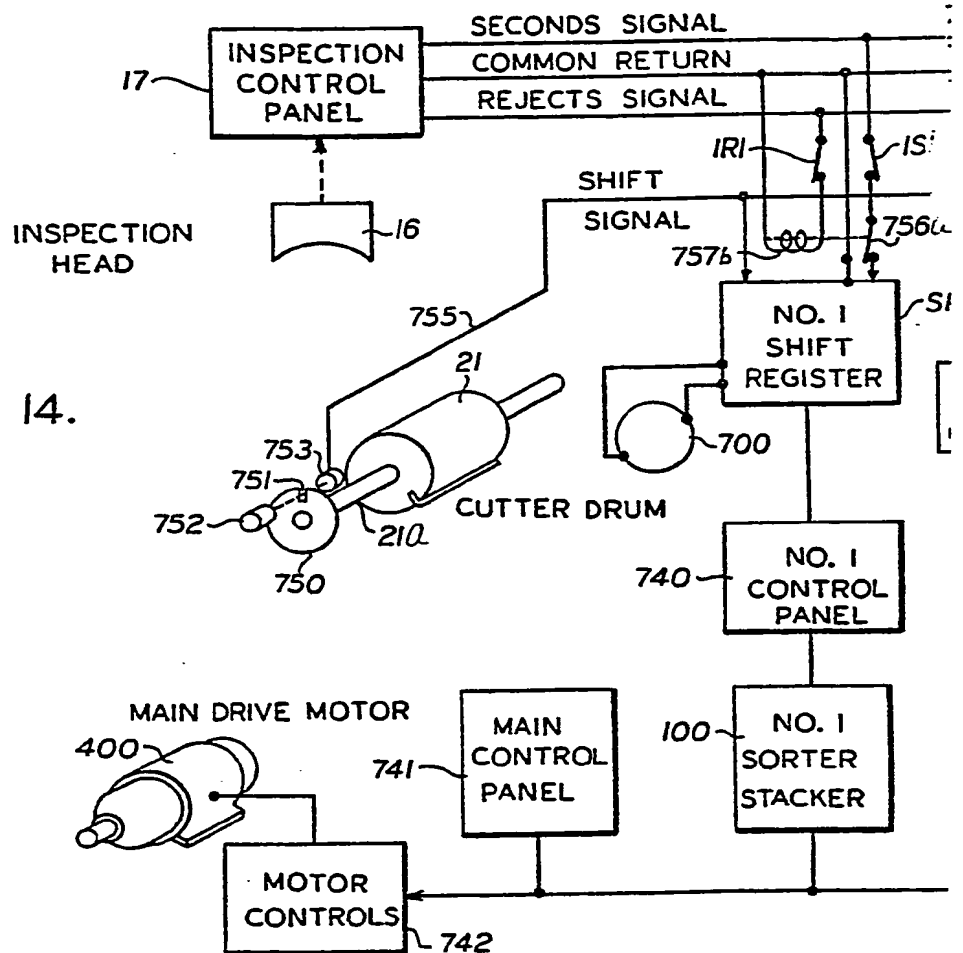


FIG. 14.



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